ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Vol. XXXVI., No 21.

TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK 321, 336
A Bridge Truss Without Diagonal Members (illustrated) 322
The Trans-Siberian Railway (with inset)..... 322
The Application of Suction Pipes to the Handling of Grain at Millwall Docks, England (illustrated).... 324
The Gold Mines of North Carolina..... 325
Valve Box and Capstone used on the Water-Works of Syracuse, N. Y. (illustrated)..... 327
The Application of Photography to Surveying (illustrated) 331
Steel Canal Boats (illustrated)..... 332
Novel Arrangement of a Traveling Cableway (illustrated)..... 333
The Longest Continuous Railway Run in the World. 333
Speed Trials of a Screw-Propelled Ferry-Boat (illustrated) 334
A Water-Works Plant for a Village of 300 Inhabitants 336
EDITORIAL NOTES 328
The Supreme Court Decision on the Wright Irrigation Law and its Effect on Irrigation Enterprise—The Prospects of Gold Mining in the South—A Fast Long Distance Train in England—Lessons of a Scaffold Accident—Louis Baldwin Howell, Obituary.
EDITORIAL:
A Survey of a Great Lakes & Hudson Ship Canal (illustrated 329
LETTERS TO THE EDITOR..... 330
Thenard Movable Dam—Patents on Hydraulic Dredges—Specifications for Water-Tube Boilers for the St. Louis Water-Works.

THE WRIGHT IRRIGATION DISTRICT LAW of California was upheld as constitutional by the United States Supreme Court on Nov. 16. This act authorizes owners of irrigable lands to form irrigation districts, levy taxes, issue bonds and construct irrigation works. It has been subjected to repeated attacks in the courts of California, but has always been upheld there. About the middle of 1895 Judge Ross, of the U. S. Circuit Court for the Southern District of California, declared the law unconstitutional, in that it took away private property without due process of law. The U. S. Supreme Court now reverses this decision, Judge Peckham, in his opinion, not only stating that property taken under the act is appropriated to a public use, but that if it were otherwise, any general irrigation scheme would be impossible. Ex-President Benj. Harrison appeared for the irrigation districts in the suits. Comments on the decision will be found in our editorial columns.

THE NEW ORLEANS DRAINAGE COMMISSION proposes to start work as soon as possible, in accordance with recommendations just submitted by Maj. B. M. Harrod, Vice-President Am. Soc. C. E. The work involved in these recommendations is largely the extension and improvement of canals, but also includes two pumping stations, each estimated to cost $150,000. The estimated cost of the canal work now proposed is $630,000. The commission has nearly $600,000 of cash in hand and from $200,000 to $300,000 more available within two years, while it may issue $500,000 of bonds, if necessary. The commission is constituted as follows: President, R. M. Malmsley; W. C. Flower, Mayor of New Orleans; A. Brittin, President, C. F. Claiborne and L. Cucullu, members city council; Otto Thomas, President, Paul Capdevielle and M. Abascal, members Levee Board; and J. C. Morris, member Board of Liquidation, City Debt. Maj. Harrod, as already stated, is Engineer, and Mr. A. F. Theard is Chief Draftsman of the commission. Mr. A. C. Bell is now City Engineer of New Orleans, having succeeded Mr. L. W. Brown, who carried on much of the investigation preliminary to the drainage work.

BIDS FOR STREET CLEANING AND GARBAGE disposal at Philadelphia will be received until Nov. 25. The contract runs for only a year, and as large garbage disposal plants are now owned and operated by the present contractors it seems likely that there will be but little change in the contractors for this service.

THE BROOKLYN GARBAGE contract has been awarded to the Brooklyn Sanitary Co., of which Mr. F. L. Cranford, of Brooklyn, is President. The contract is for the collection and disposal of ashes for five years, from Jan. 1, 1897, and the prices for the successive years, from first to fifth, are as follows: $113,000, $117,000, $120,000, $125,000, $130,000. The Arnold system of garbage utilization will be used for disposal, the same as is now in use for treating a large part of the garbage of Philadelphia, and will soon be used for all the garbage of New York.

THE VALVE AND HYDRANT EXHIBITION under the auspices of the Department of Public Works, New York city, noted in preceding issues, is in progress as we go to press, and promises to be very satisfactory. There are a large number of exhibits, as will be seen by referring to the detailed list published in the columns of "Industrial Notes" in our supplement. A large number of different makes and styles of hydrants and valves have been connected to a testing stand and each is being tested to determine the amount of water passing per minute, the pressure at the inlet and outlet, and possibly other features. After this test is completed, the several valves and hydrants will be taken apart and put together again, the time taken in each operation being noted. Besides valves and hydrants, pipe tapping, cutting and calking machines, cutting-in-specials, lead melting pots, and other devices more or less closely related to the valve and hydrant service are being shown. The exhibit will be judged by the following officials of New York city: Geo. W. Birdsall, Chief Engineer Department Public Works; Horace Loomis, Engineer-in-Charge of Sewers; Edw. P. North, M. Am. Soc. C. E., Water Purveyor; Hugh Bonner, Chief Fire Department; and Alonso S. Gear, General Foreman Corporation Yards. The water used in the test is being measured by Venturi and Crown meters and the pressures observed by means of gages made by the Ashton Valve Co., of Boston, Mass. The chief novelties in the exhibit are the large pipe tapping machine, tapping and connecting a 36-in. with a 48-in. main under pressure, and a steam pipe calking machine, regarding which we hope to say more in a later issue.

BONDS FOR THE PURCHASE OF THE DULUTH Water-Works have been voted by the city. The present plant is owned by the Duluth Gas & Water Co., which, it is reported, will be transferred to the city for about $1,500,000. The city has for some months past been constructing new intake works.

THE OHIO RIVER IMPROVEMENT ASSOCIATION held its first annual convention at Pittsburg on Nov. 10. The object of this association is the securing of legislation and immediate work tending towards the improvement, with dams and locks, of the Monongahela, Allegheny and Ohio rivers. Speeches were made by many interested setting forth the great commercial advantages of such improvement, and a resolution indorsing the proposed ship canal was prepared for presentation to Congress. The officers elected for the coming year are: President, John L. Vance; Secretary, E. P. Wilson; Treasurer, J. D. Parker, and for vice-presidents and executive council, Messrs. John F. Dravo, C. B. Hart, John Ingle, W. W. Hite, W. P. Halliday and F. A. Laidley.

THE IMPROVEMENT OF THE POTOMAC RIVER, at Washington, D. C., says Gen. Craighill, Chief of Engineers, U. S. A., has cost $2,088,047 since the beginning of work in August, 1882. There is now a 20-ft. navigation channel in front of the city and old channels have been widened; besides this, a tidal reservoir, 8 ft. deep and covering 111 acres, has been dredged, 32,645 ft. of sea wall and 5,775 ft. of training dike have been built and 621 acres of land has been reclaimed by filling from 7 to 12 ft. above low tide. Gen. Craighill again calls attention to and recommends the rebuilding of the Long Bridge across the Potomac River.

THE HARLEM RIVER SHIP-CANAL PROJECT, proposing deep water connection with Long Island Sound, is to be again presented to Congress, with a bill asking for $2,500,000 for this work. This canal would be 3,400 ft. long, improving Bronx Kills, a shallow water course about 300 ft. wide connecting the Sound and Harlem River around the north end of Randall's Island. The proposers of this enterprise claim advantages for a Sound entrance for ocean steamers, and contend that the demand for another entrance to New York is already apparent in the crowding of the lower bay. The improvement would doubtless be advantageous to property on the Harlem, or rather Port Morris water front.

THE NEW YORK STATE CANAL improvements will be undertaken as soon as the canals are closed for navigation, which will be about Dec. 1. The blasting and excavation work will be prosecuted during the winter, and much of the other work can be done after the re-opening of the canals in the spring. Contracts have already been let for work aggregating about $4,000,000. The present average depth of the Erie Canal is 7 ft. and this will be increased to 9 ft., while some of the locks will be lengthened. The immediate result of the improvements will be that boats of 16 ft. greater length, 2 ft. greater draft and 100 tons more freight capacity can be used.

THE NORTH RIVER BRIDGE CO., at its annual meeting, re-elected Mr. Jordan L. Mott as President and Mr. Samuel Rea as Vice-President; Mr. Charles J. Canda was made Treasurer and Mr. Thomas B. Rea, Secretary. This is the bridge company chartered by Congress to bridge the Hudson River with a New York city landing at Twenty-third St., on plans made by Mr. G. Lindenthal, M. Am. Soc. C. E., as Chief Engineer.

A BRIDGE OVER THE OHIO RIVER, at Marietta, O., is proposed, and surveys are being made under the direction of Mr. Feikel, C. E., of Pittsburg, Pa. The bridge approach is to commence near the Marietta union station and terminate on the heights at Williamstown, on the other side of the river. It is to be a railway and highway bridge, forming a connection for a proposed railway to the mineral fields of West Virginia. The cost of the structure is put at about $3,000,000, and the bridge and railway projects are said to be backed by Mr. William Jutte, of Pittsburg.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was the derailment of an express train on the Louisville & Nashville R. R., near Montgomery, Ala., Nov 13. Train wreckers had removed a rail and piled ties on the track. Three persons were seriously hurt.——A head collision between a southbound passenger train and a northbound freight train occurred Nov. 14 on the New York, New Haven & Hartford R. R., at Naugatuck, Conn. Two men were injured and several cars were burned.

A DYNAMITE EXPLOSION occurred Nov. 14 in the office of E. D. Smith & Co., contractors for the extension of the wheel pit of the Niagara Falls Power Co., Niagara Falls, N. Y. Three men were killed and three or four injured.——A dynamite explosion occurred Nov. 10 at Germantown, Pa.; a laborer was preparing cartridges for use in blasting on the Magnolia Ave. sewer when the explosion took place. One man was killed.

A FLOOR COLLAPSED in the Atlantic & Pacific Tea Co.'s store-room on Vesey St., New York city, Nov. 11. Boxes of tea had been piled on the floor, causing a portion, about 25 x 35 ft., to give way. Nobody was hurt.

A BRIDGE AND SCHOONER collision occurred at the Craigie Bridge, Boston, Mass., Nov. 11. The schooner was just preparing to pass through the draw when a sudden squall caused it to drift against the bridge, crushing in the side of the roadway and tearing down the wires of the West End Electric Ry.

A BROKEN SHAFT on the steamer "Anchoria," of the Anchor Line, was repaired at sea during the latest voyage from Glasgow to New York. The accident occurred about 130 miles east of Sandy Hook.

LANDSLIDES AND WASHOUTS are reported from a number of railways in the Pacific northwest as the result of recent heavy storms and floods. Between Tacoma, Wash., and Portland, Ore., a heavy landslide has blocked the Northern Pacific R. R., while about 50 miles of the Cascades Division of the Great Northern Ry. have been washed out. The Canadian Pacific Ry. has several washouts on its line through British Columbia.

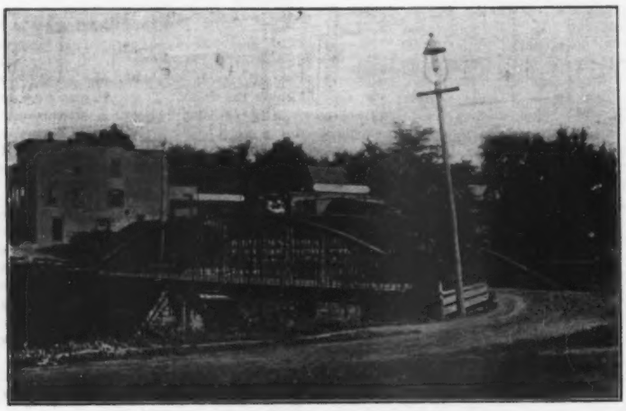
AN ACCIDENT HAPPENED TO A PASSENGER ELEVATOR in the 22-story office building of the American Tract Society, Nassau and Spruce Sts., New York, on Nov. 14, by which one man had both knee caps fractured and ten others were badly shaken but not seriously injured. The car was descending and was about to stop at the tenth floor, when the operator found that his lever had no control over the car. It continued down the shaft at a speed considerably higher than the normal, but yet not high enough to throw into gear the automatic catches, and struck on the rubber buffer stops at the bottom of the shaft in the cellar, rebounding several feet. The cause of the accident was the breaking of one of four bolts in the cover of a check valve, located in the pipe running between the hydraulic pressure pump and the hydraulic cylinder, which allowed the gasket of the cover to blow out and the water to leak out of the cylinder through the opening thus made. A high pressure hydraulic elevator plant is in use in the building, the pressure being about 900 lbs. per sq. in.

A REMARKABLE ELECTRIC WIRE ACCIDENT took place in Calais, France, on Nov. 6. While a huge boiler was being drawn through the streets by 16 horses the upper portion of it came in contact with overhead electric-light wires, breaking them. Some of the wires caught on the boiler and the framework of the truck, and in an instant all the horses were knocked down. Several of them were killed. The men engaged in transporting the boiler received violent shocks, some of them being probably fatally injured.

THE BOSTON ELEVATED RAILWAY CONTROversy has come up again, through the desire of the Boston Elevated Ry. Co. to lease the West End Street Ry. Co. The charter of the former permits the use of either the Meigs or the New York systems of construction, but no definite route or plans have yet been adopted.

A BRIDGE TRUSS WITHOUT DIAGONAL MEMBERS.

We are indebted to Mr. G. Leland FitzGerald, M. Am. Soc. C. E., for a photograph of a somewhat remarkable highway bridge in Hoosick Falls, N. Y., which is here reproduced. It has a span of 117 ft., with a rise of 12 ft. at the centre, and the top and bottom chords are connected by vertical members only. As nearly as can be learned from the photographs forwarded the arch is made of Phoenix columns; but just how the connections are made is not plain. In view of the absence of all diagonal members in the truss, it is not remarkable that a conspicuous sign on one of the two transverse overhead "stiffeners" should give warning that a fine of $5 is imposed "for driving over this bridge faster than a walk." Mr. FitzGerald writes that the bridge responds, by vertical vibrations, "with impartial nimbleness to a heavy load or a few children." It was built in 1869 by the Continental Bridge Co., of Philadelphia, under the patent of Joseph G. Henszey, and is still in use. To the best of our knowledge it is the only bow-string truss actually erected without diagonals or their equivalents, and it is interesting as a reminder of the "queer things" in bridge construction, which were accepted by the generation just past.



A CURIOSITY IN BRIDGES AT HOOSICK FALLS, N. Y.

THE TRANS-SIBERIAN RAILWAY.*

(With Inset.)

The Trans-Siberian railway unquestionably ranks as one of the most notable engineering works of this generation, both in magnitude and difficulty of execution. From time to time Engineering News has recorded the progress of this railway and given occasional technical details relating to its construction, but in view of the present advanced stage of the enterprise and the certainty, almost, that its completion is only the matter of a few years it seems desirable to consider the project in a somewhat more complete and comprehensive article. Owing to the easily understood difficulties of obtaining explicit information from a country of Russia's remoteness and character such a discussion must fail in presenting exact structural details, but enough is known to enable a fairly complete comprehension of the general type of constructions adopted, and of their magnitude and extent. In a future article it is hoped to present more detailed information.

Economic Questions.—To understand the economical significance of the Trans-Siberian railway, the possibilities of industrial development presented by the country it traverses must be understood, and there is considerable misconception upon this question. Because vast areas of Siberia are undeveloped and uninhabited, and because other vast areas have a climate of almost arctic severity, it is frequently assumed by people that Siberia as a country is a bleak, desolate region almost incapable of inhabitation and development. This is not true, as even a very cursory study of the climate, soil, mineral resources, and flora and fauna of the country will show. Space is not available to present the proofs of these statements here, but they are available in the greatest detail in various Russian Government publications and in other places. In a general way, however, a glance at the accompanying map will show that an enormous area of the country lies in mean geographical latitudes, and that within this area are included the meadow lands or steppes renowned for their fertility, and already competing with America in supplying wheat and other cereals to the European markets. Iron and coal, the two great factors of industrial development are found all over Siberia and in rich and often contiguous deposits. Mercury, lead, tin, copper, salt and other minerals also exist to varying extents, and where there are water routes are working with profit. The precious metals, gold and silver, are also found in a number of deposits much richer than the poorer deposits now worked in America. As yet none of these minerals have been worked in a thorough and extensive manner, owing to the small local demand and the lack of transportation facilities to outside markets.

Space to develop farther this presentation of facts will not be taken, but it will become evident, as the subject is more closely studied, that Siberia, over vast areas at least, is a country lacking development, and not a country incapable of development. The principal barrier to this development has been a want of transportation facilities, and realizing this the Russian Government has planned the Trans-Siberian railway, and, besides, is vigorously pushing other railway, waterway and colonization schemes. There is little doubt that questions of both national and international politics also enter very extensively into the Trans-Siberian railway scheme, or else the immediate expenditure of $270,200,000 in a project, which will not for a long time prove remunerative in the strict monetary sense of the word, would not have been undertaken so cheerfully. This, however, should not make us construe the Trans-Siberian railway solely as a military project, as is sometimes done. What should chiefly concern us is that this road serves to open up to the markets of the world vast natural advantages and resources which will ultimately compete with the advantages and resources of the North American countries in supplying European markets. The road means that Europe is to be connected to the Pacific and the far east, with Japan and China, by an uninterrupted line of railway communication. It opens a new route for the world's trade, as well as for Russian trade, across the country which has been aptly called the "Russian Canada."

Little more than a hint at the economic questions involved in the construction of the Trans-Siberian railway has been attempted here, for the purpose has been simply to invite attention to possibilities, which, so far as published evidence goes, Americans in general have not adequately considered. This being done we may turn to the more technical features of the enterprise.

Inception of the Enterprise.—As early as 1857, schemes were proposed by various persons for the development of railway lines in Siberia. One or two of these hinted at a Trans-Siberian line, but for the most part the proposed lines were comparatively short extensions of the railway system of European Russia into the western territories of Siberia. None of these projects were carried out in their entirety, but as the European system developed, its lines occupied portions of their proposed routes. It is not necessary to trace this development in detail, but by the end of 1890 the Russian railway system projected east in three lines whose extreme eastern terminations were Tiumen, Miass and Orenburg. By the same year the advisability of a Siberian extension of the European system had become more patent to government officials and the problem of construction had been placed in the hands of a special commission. After thoroughly canvassing the relative advantages of the above-named towns for a starting point it was finally decided to make the extension east from Miass. The eastern terminus was fixed at Vladivostok without question, as other point there was none in any way suitable for the purpose.

In consequence of this decision the construction of the road was determined upon on Feb. 21, 1891, and on March 17 this decision was affirmed by an imperial rescript. On May 12 this rescript was promulgated by the Grand Duke, the Czaravitch, now Czar Nicholas II., and on the same day His Imperial Highness formally began the great work of construction. In the same year surveys were commenced from both termini of the route, and by the end of the year the order of construction had been finally settled.

Route and Country Traversed.—The route finally adopted for the Trans-Siberian railway is shown on the accompanying map. From Cheliabinsk to the Obi River, the line, with few exceptions, runs through a fertile zone, where the climatic conditions are favorable to the cultivation of cereals, and encounters very few obstacles to easy construction. At the crossings of the rivers Tobol, Irtysh, Ishim and Obi there will be rather large and expensive bridges. The limiting grades do not exceed 1 in 740 and the minimum radius of curvature is 1,750 ft. To the River Obi from the starting point is 877 miles. After crossing the Obi the line as far as Achinsk, 364.7 miles, traverses a hilly country with maximum grades of 1 in 800 and curves of 1,750 ft. radius. Bridges of considerable size are required at the rivers Obi, Tom, Yaya, Yiya and Tchulim.

Further on, from Achinsk to Irkutsk, 788 miles, the character of the country completely changes and assumes a mountainous aspect. Besides several large rivers the line crosses numerous small tributaries near their summit levels and much heavy construction is required. The largest bridge, 3,150 ft. long, is across the Yenisei River, at milestone 1,356; but between milestones 1,279 and 1,312, before reaching this bridge, there are several grades of 1 in 150 and curves of 1,050 to 840 ft. radius. After crossing the Yenisei River the line begins its ascent to the summit level, winding through the valleys of the Berezovka and Sitik Rivers, which have steep and rocky sides, so that frequent cuttings, slope paving, and stream diversions are required. Within a distance of 44 miles here, there are 82 small bridges and culverts. Near milestone 1,500, the River Kan is crossed by a bridge 1,400 ft. long, which will have to be built on caisson foundations. From this structure to milestone 1,710 there is considerable heavy embankment work and two wooden viaducts 140 ft. high and 805 ft. and 875 ft. long, respectively, over ravines. Proceeding to the town of Uktouisk the line passes over a level tract of country with grades of 1 in 900 and curves of

*The information from which this article has been prepared has been collected from Russian Government publications, U. S. Consular Reports, the technical press and the proceedings of various engineering societies, and only in the case of the government publications does it bear the stamp of official authority, but a careful attempt has been made to eliminate all incongruities in the unofficial information, and as a description of the broad general features of the work it is believed to be substantially accurate.

1,750 ft. radius and no heavy embankment, but with three bridges 1,050 ft., 700 ft. and 875 ft. long, respectively, crossing the rivers Uda, Iya and Oka. From the Oka River to Polovina another mountainous section is traversed, but thence to Irkutsk the grade is about 1 in 900 at a maximum, with only one bridge of any size. This is 875 ft. long and crosses the River Belaya.

From Irkutsk, along the shore of Lake Baikal, to Mysovsk the work is quite difficult, as the line passes through a frequently flooded valley and thence into the rocky gorge of the Irkut River, where numerous dikes and retaining walls and one tunnel, 224 ft. long, are required. Between milestones 2,093 and 2,095 there will be a tunnel 12,530 ft. long. Continuing beyond this tunnel the line runs through the narrow rocky gorge of the Ilcha River, where it must occupy part of the river bed, and be built on embankment held by retaining walls, and thence through a mountainous country to milestone 2,126. Along the whole mountainous section all the cuts will be in hard rocky ground and in some places the embankment must be of stone, as no soft soil is available. The greatest cuts are from 77 ft. to 105 ft. deep, and the deepest fills are about 118 ft. From milestone 2,126 along the shores of Lake Baikal the country loses its mountainous character, but as the line in many places is close to the lake shore a very considerable amount of protecting cribwork is demanded, and there are also numerous bridges and culverts crossing streams flowing into the lake. To protect the roadbed from water will be the greatest task along this whole shore line.

A few figures will aid in understanding the difficulties described in the preceding paragraph. From Irkutsk to Mysovsk is 107 miles, and the construction of this length of line will require 12,700,000 cu. yds. of embankment, 2,749,000 cu. yds. of excavation, and 315,000 cu. yds. of masonry. The section through which the line passes is completely desert except for a few small settlements along Lake Baikal; but the heavy fall of snow prevents the deep freezing of the soil which is encountered further along the line, as will soon be noted.

Beyond Mysovsk the line gradually leaves Lake Baikal and climbs the Yablonovoi Mts., where at milestone 2,610 it reaches its highest point, and it then descends to Sretensk on the River Shilka. The work on the whole is very difficult mountain construction, the line hugging the mountain declivities or passing along the frequently submerged river banks. The length of the Mysovsk-Sretensk section is 668 miles and on it there are 25,800,000 cu. yds. of excavation and embankment, nearly 3,800,000 cu. yds. of which is in rocky ground. The deepest cuts are about 116 ft., and the greatest fills about 75 ft. About 711,000 cu. yds. of retaining wall will be required to support the embankment at various points.

Added to all else is a climate of great severity, and either a desert or dense virgin forest country totally uninhabited over vast tracts. For example, in the Yablonovoi Mts., the temperature rises to 77° F. in day time and falls to 23° F. at night during June and July. At the town of Verkhneoudinsk in 1886 the temperature was above freezing for only three months; in 1887 it was above freezing for one month and at almost freezing for two months. From 1886 to 1888, inclusive, the highest temperature recorded was 98° F. and the lowest -52.6° F. As the atmosphere is dry and very little snow falls, the ground is frozen all the year round. According to investigations made in the valley of the Chita River, through which the road runs, the depth to which the soil freezes averages about 24½ ft. In summer the top soil is thawed to a depth of about 12⅞ ft. so that the remaining 11¾ ft. is eternally frozen. These are by no means the records of greatest severity.

From Sretensk to Khabarovka, 1,324 miles, the country penetrated is topographically about the same as that through which the Mysovsk-Sretensk line just described passes, being desert and dense forest. But from Khabarovka to Vladivostok, 482 miles, the country is more open, though quite a number of large bridges and other important constructive works will be required. In a few places the grades will be 1 in 150, but generally about 1 in 800.

The topography of the route and the character of the construction required throughout the whole distance from Cheliabinsk to Vladivostok, 4,708 miles, have now been described in their general features, and attention may be turned to the constructional features of the road.

Construction.—For purpose of construction the line is divided as follows:

No.	Section.	From and to.	Miles.
I.	Western Siberian	Cheliabinsk to Obi River	878
II.	Central Siberian	Obi River to Irkutsk	1,162
III.	Baikal	Irkutsk to Mysovsk	194
IV.	Transbaikal	Mysovsk to Sretensk	667
V.	Amoor	Sretensk to Khabarovka	1,325
VI.	North Ussurisk	Khabarovka to Grafsk	230
VII.	South Ussurisk	Grafsk to Vladivostok	252
	Total		4,708

Note.—These divisions and distances are those given by a Russian Government report published in 1893. In several more recent, but unofficial statements, the lengths of some of the divisions are somewhat different, but as the total length of line is practically the same in all cases the older official statement is given here.

Work was begun on the West Siberian and South Ussurisk Sections in 1891. In 1893 work was begun on the Central Siberian Section. According to a recent statement, made by Prince Hilkoff, Imperial Minister of Transportation, 1,950 miles altogether have been completed, of which 1,550 miles are on the line east from Cheliabinsk, and 400 miles on the line north from Vladivostok. Between Lake Baikal and the Amoor River, about 600 miles, about half the grading is finished, and all the grading is finished between Lake Baikal and the end of the rail on the west side. It is intended to have the rails laid for the whole line (except the 1,400 miles down the Amoor, and the loop around Lake Baikal) in two years. The Amoor line may be completed in four years, but this is a little uncertain. For the loop around Lake Baikal a car ferry is to be substituted for the present, and when the ice is too thick for navigation rails laid on the ice will take the place of the ferry. For about half the year a steamboat line may be substituted for the Amoor line, and it is entirely possible that the railway will never be built if it is possible to build a favorable line across Manchuria. Recent surveys show that the substitution of the Manchuria line would shorten the total line about 665 miles, with a considerable reduction in engineering difficulties and some gain in traffic from a fairly well settled and quite productive country.

The Trans-Siberian railway, passing through an enormous expanse of country having widely differing topographical conditions, could not all be included under one type of construction. The basis adopted was always a good reliable construction, but one varied to suit the different conditions. In the level country sections the limiting grade was fixed at from 1 in 600 to 1 in 800, and the limiting radius of curvature at 1,750 ft.; but in the mountainous sections these limits were increased to grades of 1 in 150 to 1 in 174, and curves of 840 ft. radius. The width of roadbed is 16.45 ft. on embankment, and 15.4 ft. in cuts, with side slopes of 1 to 1.25. For the passage of water under the line and for crossing small streams, cast-iron pipes and stone culverts and wooden bridges are used, while the larger rivers are spanned by iron bridges with permanent masonry foundations. The track is on the Russian standard gage of 5 ft., or more accurately, 4 ft. 11¾ ins., and has 49-lb. rails on 0.875-ft. of ballast. The stations, section houses and other buildings are generally of wood, of simple construction, but in some places brick stations are built. The greatest distance between stations is about 40 miles. Water supply will be had only at stations. It should be noted that the foregoing applies to the first construction only, for as the country becomes more thickly populated and as the traffic increases additions and improvements are to be made as needed.

The illustrations here used are engraved from photographs forwarded to this journal from Irkutsk. They are especially interesting as showing the substantial character of the work done by the Russian engineers in this remote region, in high embankments, masonry, bridge construction and station buildings. The view at the stations looks familiar to the American railway builder, with the rails spiked down to wooden ties, the water tower, station platform and general arrangement.

Based upon this construction the estimated cost of the work is given in the accompanying table, a study of which will also give a very good understanding of the relative difficulties of construction on different sections. This table has been compiled from a Russian Government report published in 1893. Unofficial figures published more recently give slightly different amounts, arising partly from a different value given to the Russian rouble and partly it would seem from erroneous calculation. In order that the proportion of the cost which is entailed by large bridges and tunnels may be understood the following table of the costs of the more important of these structures has been compiled from the best available information:

Bridges.

All over 700-ft. span:		All over 700-ft. span:	
Irtysh River	$1,275,000	Oka River	$396,100
Obi River	2,100,000	Baiaya River	405,900
Tom River	1,050,000	Calinga River (1)	2,175,000
Tchulim River	544,200	Kirtcha River (1)	349,000
Yenisei River	2,362,500	Amoor River (1)	6,000,000
Kan River	749,200	Ussuri River (1)	337,500
Birinsa River	758,700	Other bridges	2,250,000
Uda River	345,500		

Viaducts.

Two on Central Siberian Section	903,500

Tunnels.

Two, total length, 12,754 ft.	2,049,800

Thus far the work has been done partly by labor imported from European Russia and partly by local labor, the material being shipped in by the completed line partly, but generally by boats capable of traversing the various navigable rivers. The simplest means are used to do the work, hand labor, carts and wagons alone being used. As many as 150,000 laborers have been employed at one time during the summer months. The plan for shipping material proposed, and the plan thus far followed in a general way, is as follows: For the Khabarovka section, by sea to Vladivostok, and then by the completed line; for the Trans-Baikal section, partly by sea to Vladivostok, then by rail to Khabarovka, and then by the Amoor and Shilka Rivers to Sretensk and also partly by rail to Irkutsk, and then by the Angara River and Lake Baikal to Mysovsk; for the Baikal section

Table Showing Estimated Cost per Mile of Different Classes of Work on the Trans-Siberian Railway Compiled from the Official Estimate.

	Cost, per mile.							
Classes of work.	I. Cheliabinsk-Obi Line.	II. Obi-Irkutsk Line.	III. Irkutsk-Mysovsk Line.	IV. Mysovsk-Sretensk Line.	V. Sretensk-Khabarovka Line.	VI. Khabarovka-Grafsk Line.	VII. Grafsk-Vladivostok Line.	Total Line.
Expropriation of land	$342	$200	$197	$581	$585	$256	$750	$421
Making of tract	5,149	8,611	28,845	15,350	16,380	15,451	11,377	12,418
Construction works	7,809	11,393	28,518	11,445	17,550	11,197	8,142	12,905
Laying the line	3,457	2,978	2,973	3,399	3,510	4,533	3,646	3,388
Appurtenances of the line	157	172	147	195	187	293	191	183
Telegraph	324	239	292	281	281	351	393	287
Buildings along the line	626	506	789	682	585	1,060	669	638
Station buildings	1,773	1,846	2,250	2,166	2,106	2,974	3,586	2,115
Water supply	544	869	716	739	702	842	971	741
Station appurtenances	580	500	790	852	819	819	1,220	722
Rails and fastenings	7,562	7,704	7,481	7,470	7,469	7,600	7,489	7,552
Rolling stock and workmen included	7,124	7,132	6,698	6,510	6,566	6,465	4,170	6,673
Carriage of rails, fastenings, etc.	2,253	3,336	3,677	5,872	5,596	4,571	2,630	4,166
General, administrative and miscellaneous	3,965	3,686	6,064	6,274	6,435	6,669	8,907	5,405
Total	$41,725	$49,232	$89,397	$61,816	$68,770	$63,081	$54,121	$57,614

Note.—In calculating this table from the Russian weights and measures, the verst was taken as 0.662 mile, and the rouble as 77.2 cts. This latter is the value of the gold rouble; the silver rouble while nominally of the same value as the gold, passes for only about 38 cts. in foreign exchange.

by rail to Irkutsk; and for the Amoor section, partly from the east by the same route as for the Trans-Baikal section and partly from the west by rail to Irkutsk, thence by water to Mysovsk, and thence by the Trans-Baikal line to Sretensk. It will be seen by studying the map that according to this plan the first work consists in completing the line east to Irkutsk and also west to Grafsk; the second is to construct the sections between the navigable rivers, and finally the third is to close the open sections. It is, of course, possible that as the work advances and the country is opened up changes may be made in this order, but such changes are more likely to appertain to the details than to the plan as a whole.

Auxiliary Works.—Auxiliary to the railway construction a large sum of money has been and will be expended in constructions designed to develop local traffic, in waterway improvements and in colonization enterprises. Branch railways are planned to connect the main line with nearby mineral districts and favorable water routes, and wharves and docks are being built. Large sums are also being expended in geological and mineralogical work intended to exploit the mineral resources available, and similar work is being done to develop the agricultural possibilities of the country. As indicating the expenditure to these ends it may be noted that when the appropriation was made for the Cheliabinsk-Irkutsk and Vladivostok-Grafsk sections it was provided that 14,000,000 roubles ($10,808,000) were to be used in auxiliary works of the kind mentioned, and it is announced officially that the probabilities are that similar amounts will be so set aside in further appropriations.

General Conclusions.—A study of the foregoing indicates that the Trans-Siberian railway is notable rather for its great length than for the structural difficulties encountered, although the latter comprise some heavy mountain work, and are augmented on certain parts of the line by the severe temperature and the desert nature of the country traversed. The type of construction adopted is substantial but rough and in a degree temporary, the American practice of bending all energies to open the line for traffic and leaving the better and more permanent work to follow, seeming to have been adopted. It has been stated in fact that the immediate model studied by those who planned the road was the Canadian Pacific Ry. The total estimated cost of the road is 350,210,000 roubles or $270,362,000, or about $57,615 per mile, calculating the Russian rouble at 77.2 cts.

The ascendency of Russia at the Chinese Court, resulting from the diplomatic outcome of the Chinese-Japanese war, may make a radical change in the Pacific terminus of the Trans-Siberian railway. Vladivostok was selected because no other port in the Japan Sea was available at the time; but it is closed by ice for a considerable part of the year and a more southerly port, open at all seasons, would be preferable when this great railway is once opened to traffic. Rumor has it that an agreement now exists between Russia and China, fixing upon Port Arthur, in the Gulf of Pichili, as a final terminus, with a necessary extension of the railway to this point through Chinese territory. Whether a new line would be located from Lake Baikal east and down through Manchuria, or whether the present line would be extended from Vladivostok to Port Arthur, it is, of course, impossible to say. But the comparatively small amount of work done on the Pacific end of the Siberian railway and the importance of bringing the line as far south as possible, might lead to an entirely new locating at this end, were Chinese territory once available for this purpose. The climatic features of construction on the Trans-Siberian line will be better realized when it is considered that the most southerly portion of the present location, excepting the Vladivostok end, lies north of 51° N. latitude. On our own continent, latitude 55° N., would strike the southern boundary of Alaska, and of Hudson Bay, pass nearly 100 miles north of Lake Winnipeg and through the middle of Labrador.

Since writing the above the "Centralblatt der Bauverwaltung" announces that the line from Cheliabinsk to the Obi River was opened to traffic on Oct. 27. At present only mixed freight and passenger trains are run, at an average speed of about 17.5 miles per hour. About the first of the coming year, however, it is proposed to run express trains at a speed of about 20 miles per hour, traversing the 1,800 miles between Moscow and Kolivan in about 4¼ days, or from St. Petersburg in 4¾ days. The present fare from St. Petersburg to Kolivan, on the mixed train, is 53 roubles, or $40.92 for first-class, and 32.60 and 20.40 roubles, or $25.17 and $15.75, for second and third-class fares, respectively.

THE APPLICATION OF SUCTION PIPES TO THE HANDLING OF GRAIN AT MILLWALL DOCKS, ENGLAND.

The foreign grain trade of the United Kingdom of Great Britain and Ireland has increased from an average of 1,022,067 tons per annum, in the ten years ending in 1850, to an average of 6,157,276 tons per annum for the ten years ending in

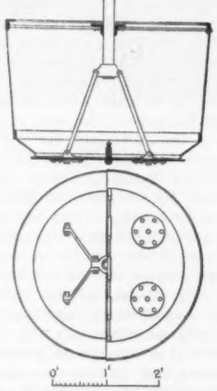


Fig. 1.—Grain Hoisting Bucket With Drop-Bottom.

1890. In 1893 the total quantity of grain and flour imported was 8,165,796 tons, valued at $255,901,855.

The Millwall Docks, in London, opened in 1858, are much used by timber and grain-ladened vessels, and Mr. Frederic Eliot Duckham, M. Inst. C. E., has lately presented a paper to the Institution of Civil Engineers upon the "Grain Appliances at the Millwall Docks," from which the following abstract is made:

The first system adopted for the unloading of grain consisted in the erection of short stages, upon timber piling, parallel to the quay wall and sufficiently far from this wall to permit a vessel to lie between the stage and the quay. On both of these were stationed movable hydraulic cranes and hoppers, running on tracks of 7 ft. 6 ins gage. The grain was lifted from the hold of the vessel by grain-tubs and delivered to the hoppers on either side, as it was to be either stored on land or delivered to barges. The grain-tub used (Fig. 1) was remarkable for its extreme lightness compared with its capacity, as it weighed only 5 cwt., and carried 60 bushels, or nearly 3 cu.

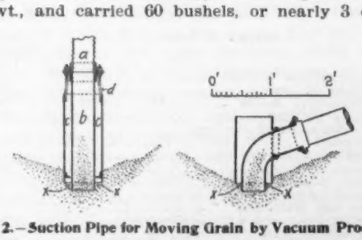


Fig. 2.—Suction Pipe for Moving Grain by Vacuum Process

yds. The shell was of 3-16 in. steel, with a 1¾-in. angle iron rim inside the upper edge. The lower end was contracted for 6 ins., with the lower diameter 1 ft. less than the upper part of the shell. This bucket was suspended by a 3½-in. tube, passing through suitable guides and provided with an eye at the top, and it was connected by four rods with the two doors forming the tub-bottom. When the tub was suspended the weight kept the doors closed, and it was emptied by seating it upon the aperture in the top of the hopper having a diameter a few inches less than that of the tub-bottom.

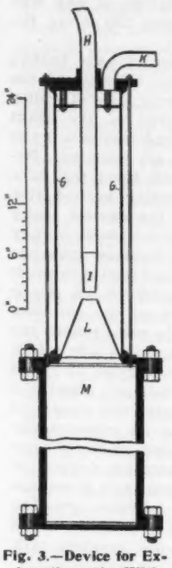


Fig. 3.—Device for Exhausting Air Without Removal of Dust.

These appliances, described in full by Mr. Duckham, were put in place in 1879 and worked successfully ever since; but time developed a number of disadvantages in this manner of handling grain. All of the grain had to be brought directly under the hatches to be shoveled into the tubs; hatches could not be kept open in wet weather without damage to the grain, long delays often occurred, and serious and sometimes fatal accidents occurred, as is apt to be the case wherever lifting gear is used. Mr. Duckham, in attempting to remedy these defects, conceived the idea of making use of air in discharging ships loaded with grain, and as the result of experiments he concluded that a suction process was better than the use of air under pressure. He ascertained by experiment the proper volume of air to be furnished to move a given quantity of grain when working with a certain vacuum and in Fig. 2 is shown the device finally adopted by him to regulate the proper working ratio of air to grain. The remainder of the description of the appliances used by Mr. Duckham we take from his own paper in the "Transactions" of the Institution, as follows:

A flexible pipe, a, leading from the ship to the vacuum chamber, terminates in an inlet nozzle, b, surrounding which there is a sleeve, cc, of such diameter as to leave an annular passage between it and the nozzle of the same sectional area as that of the interior of the nozzle itself. By the screwed rods, d, the height of the sleeve above the mouth of the nozzle is altered according to

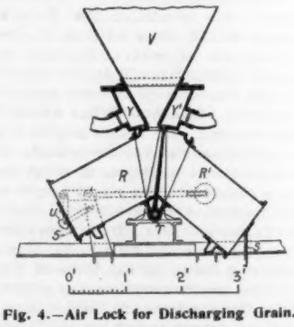


Fig. 4.—Air Lock for Discharging Grain.

the characteristics of various kinds of grain, the available degree of vacuum, etc. Regardless of the varying depth of immersion and other disturbing conditions, therefore, a regular supply of air is drawn down the sleeve. There can never be a greater body of grain to resist its progress towards the nozzle than that marked XX, which is carried on with the air while the surrounding grain continually flows down to refill the vacated space, to be in turn carried up by the nozzle. A wire grid or muzzle covers the mouth of the inlet-pipes when they are worked near the mats and similar divisions between different bulks of grain. The nozzle is made in various shapes, such as the bent form shown in Fig. 2, for use between decks and in similar confined spaces.

The separation of the air from the grain was not difficult. In its imported condition, however, grain always contains a quantity of dust, husk and foreign matter, and during the early use of the machine, the exhaust air carried off some of the dust and lighter particles,

with the result that, although the value of the grain was increased, its weight was diminished. Merchants who sold by weight upon a sample from the ship objected to the use of a machine which, though it improves the quality of the grain, deprived them of a small part of its weight. The improved condition of the grain had therefore to be sacrificed to the maintenance of the shipped weight, and so it became necessary to find some means of weighing and delivering the grain in the same condition as to dirt and dust as it arrived in the ship. Several methods were tried, including those employed in flour mills, etc., but with unsatisfactory results. In the course of the author's experiments a glass vessel was used, so that the action of the machine under various conditions might be seen. The arrangement is shown in Fig. 3, where GG is the glass vessel, H a flexible pipe leading from the dusty material experimented upon, and terminating in the adjustable nozzle I. A pipe, K, leading to the exhauster, L a funnel with its rim fitted air-tight in the closed chamber M. When in operation the partial vacuum of, say, 10 ins. mercury, drew grain-laden air in through the pipe H, at a speed of about 35 ft. per second, imparting to the solid particles such momentum that they were projected across the gap between the nozzle and the funnel into the comparatively still chamber M. But the air that had conveyed them was unable to penetrate or displace the somewhat denser air in the chamber M, so it is drawn off to the exhauster through the pipe K. No loss whatever could be discovered by the most careful weighing of a bushel of dusty barley before and after being passed through the apparatus.

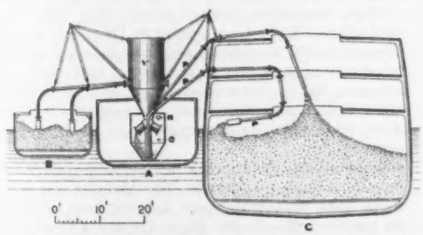


Fig. 7.—Section Showing Transfer of Grain From Barge to Ship's Hold.

A loss of but ¼-oz. was found in 14 lbs. of fine, light dust. This apparatus on a larger scale was therefore added to the machine and a by-pass provided by which the dirt deposited in the closed chamber could be returned to and mixed with the grain in the vacuum-chamber. More recently, however, the disadvantage of this procedure has been recognized, and instructions are often received to keep impurities separate, and deliver the grain in its improved condition, which in some instances is represented by an increased value of several shillings per quarter.

The air-lock by which the grain discharges itself from the vacuum-chamber is shown in Fig. 4. It is a twin box, RR¹, mounted to rock on the trunnion T. Its upper side is machined to a segment of a circle with T as its center, and on this surface each box has its own oblong port for the admission of the grain. At the lower end of each box is an outlet closed at times by the flap-door S. To the lower end of the vacuum-chamber, V, is fixed a cast-iron outlet machined to make a practically air-tight joint with the segmental part of the rocking-box. The outlet from the vacuum-chamber has one oblong port corresponding with that in either box. With the box in the position shown in Fig. 4, the left-hand compartment, R, is under the same pressure as the vacuum-chamber, from which it would be receiving grain, while the outlet flap S would be kept closed by atmospheric pressure. When this compartment has received its full load it tips over and brings the right-hand compartment, R¹, into the loading position, the partial vacuum being broken and the grain discharging itself through the flap door. It was found that some detent mechanism was desirable to prevent the box rocking with so small a load as might lead to its sticking half way, and also that with the vacuum-chamber under vacuum and the box filled with air nder atmospheric conditions, the downward stream of grain through the port was retarded by the upward pressure of the expanding air which the box contained. To meet these difficulties the two auxiliary ports, YY¹, were added to the outlet and by means of a by-pass are kept under the same vacuum as the chamber V. Trigger-gear, U, was also fitted to each end of the rocking box to allow the loading-compartment to make a first stage of its movement unrestrained, and in doing so to bring the port of the compartment that has emptied itself into connection with the auxiliary port Y, its air being reduced to the same state as that in the vacuum-chamber. The loading continues until the weight in the box is sufficient to pull off its trigger; when the second stage of its movement is completed the flap-door opens and the other box is brought to its loading position and the operation repeated. The jockey-weights on the trigger steelyards are adjustable to approximately conform with any required weight of a box load of grain.

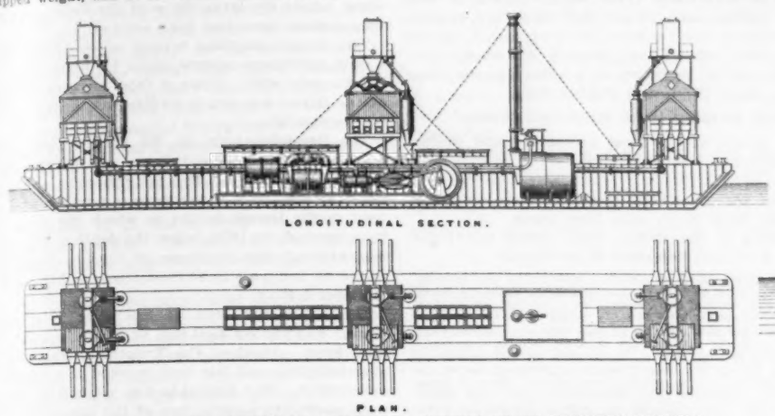


FIG. 5.—PLAN AND SECTION OF BARGE FOR MOVING GRAIN BETWEEN VESSELS AND STORAGE BINS BY VACUUM PROCESS.

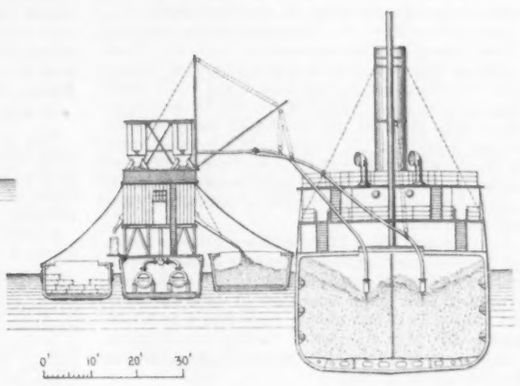


FIG. 6.—CROSS-SECTION SHOWING BARGE TRANSFERRING GRAIN FROM A SHIP'S HOLD TO BARGES ALONGSIDE.

The machine as in use at Millwall Docks is shown in Figs. 5 and 6. To meet local requirements it is placed on a barge, the "Mark Lane," 170 ft. long by 18 ft. 6 ins. wide. A horizontal compound surface-condensing engine, with steam cylinders 15 ins and 28 ins. in diameter, with 4-ft. stroke, is used for exhausting. Each piston rod is continued through the back end of its cylinder and connected direct to two air-exhausting pumps 38 ins. in diameter. On the deck there are six sets of apparatus, each with its vacuum-chamber, its suction-hose for conveying the grain from the ship, and its rocking air-lock through which the grain discharges itself into an open hopper, and whence it is weighed and delivered either loose or in sacks. The capacity of such a machine is proportional to the power of the exhausters. The "Mark Lane" can transfer wheat from a ship to a barge at the rate of 90 tons per hour. The "Baltic," a similar machine now at work at the Royal Albert Dock, has steam cylinders 22 ins. and 40 ins. in diameter, and has lifted 180 tons per hour.

The amount of steam power employed to elevate a given quantity of grain is greater with this than with the ordinary elevating machinery, but the pneumatic process removes satisfactorily the objections already referred to, and possesses many advantages over the ordinary elevator. Its suction-pipes are taken to the grain wherever it may be, even in the bunkers and cupboards, and the trimming of grain on board ship is thus almost entirely obviated. By means of convenient suspended tackle, one attendant only can easily manage a suction-pipe lifting 30 tons or 40 tons per hour. As the conveying-pipe also occupies so small a part of the hatchway, other goods may be simultaneously unloaded by cranes or other tackle. During wet weather the hatchways are covered, room being left only for the pipe, the receiving-barge is protected by an awning, and the discharge proceeds uninterruptedly. No grain is split during the process, for it is conveyed within closed conduits from the ship's hold to the barge. The dangers attending the use of ordinary hoisting-gear are avoided, and the discharge of a cargo may be commenced within a few minutes of its arrival alongside the machine. The total cost of discharge, including labor, coals, wear and tear, and other charges, is considerably less by this than by any other existing method.

Machinery of this kind is as applicable to loading as to discharging cargoes. The loading may be effected either by raising the vacuum-chamber to a sufficient height to allow the grain to flow into the ship's hold by gravity, or it may be temporarily placed over the ship's hatch, or, preferably, in the case of ocean-going vessels, the arrangement shown by Fig. 7 may be adopted. In it the vacuum-chamber is placed as low as it conveniently can be on board the elevator-barge, and the oscillating air-lock is enclosed, and discharges its contents into the chamber O, to which air under pressure is admitted through the pipe N, and the grain is expelled through the pipe P into the ship's hold. A great advantage of this arrangement is that the grain is not simply dropped down the hatchway, but is carried by the pipe to any part of the ship, and there deposited quietly without trimming. Where it is required to weigh the grain during the operation of shipment, weighing machinery is inserted between the vacuum-chamber and the chamber O, and a second air-lock employed. There are other adaptations and combinations of the process for lifting and conveying any grain-like material afloat or on shore, and for transfer direct between ships and granaries. Steam-barges fitted with tanks to accommodate 800 tons or 1,000 tons of grain may empty themselves by air-pressure produced by their own propelling-engines. The limits of the capabilities of this process have not yet been reached, but wheat has been transmitted 800 ft., including a lift of 80 ft.

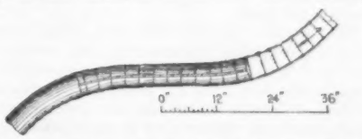


Fig. 8.—Flexible Steel Suction Pipe for Handling Grain.

The beneficial effects upon grain worked by the pneumatic process arise chiefly from the areating and brightening of the grain in passing through the pipes; but, in addition to this, the flow of exhaust air may be arranged, when required, to carry off much of the light husk and dust. This process has proved so successful that, over and above the ordinary operation of discharging cargoes, merchants often send their grain to the "Mark Lane" to be passed through it. The consequent increase in the value of the grain undergoing this process is considerable.

Great difficulty existed in obtaining flexible pipes to withstand the wear and tear of the grain passing so rapidly through them. Ordinary suction-hose with embedded steel-wire, lined with a composition of rubber, used as stencil masks in the sand-blast process, was the best obtainable, but was soon worn through. It was, however, found that satisfactory results could be obtained from rigid steel pipes. The author thereupon adopted the combination shown by Fig. 8, in which a number of truncated cones of plate steel are strung together by external tapes in such a way that the smaller end of one cone enters about ¼ in. into the larger end of the next. The steel rings resist wear by friction of the grain, and, being enveloped by ordinary rubber hose, are perfectly air-tight. The combination is so flexible that a 6-ft. length, 8 ins. diameter, may be bent through 90°. These have now been some time in use, and answer the purpose admirably.

THE GOLD MINES OF NORTH CAROLINA.

By Maxwell J. Gorman.*

The gold-bearing formations of North Carolina include nearly one-half its entire area. The productive portion of this area which has been worked, either commercially or experimentally,

*Special correspondent of Engineering News, Raleigh, N. C.

will not exceed 10,000 sq. miles; and while there are more than 350 localities which have been worked for gold, most of them prior to the war, and where work has not been resumed since, there are at present relatively few mines in operation.

Just when gold mining was first undertaken in North Carolina is not definitely known, but there are traditions that the auriferous character of the section was known prior to the Revolution.

The Oliver Mine, in Cabarrus county, and the Parker Mine, in Cherokee county, are two of the mines in the state which it is reasonably certain were "worked" before that period, the latter being said to have been "operated" by the Cherokee Indians long prior to the advent of white settlers in that section of the country. The Brewer Mine, in Chesterfield county, S. C., is another "old-timer" which is known to have been worked in some manner before the first period of which we have authentic record.

In the year 1799, a 17-lb. gold nugget was found on the Reed plantation in Cabarrus county, where since that date hundreds of pounds of gold in nuggets have been taken from time to time, one nugget valued at $7,000 having been found and sold during the past summer. One of the nuggets found some years ago was assayed as containing $18,000 worth of gold.

Within 25 years after, or about 1823, gold mining on an extensive scale was being prosecuted at various points along the entire Appalachian slope, from Virginia to Alabama. The placers and similar deposits were first worked, then the gossan outcrops of the veins, where crude appliances and little skill were necessary to effect profitable results. These easily-worked stores were about exhausted, apparently, about the time that the California gold excitement struck the country, and nearly all the miners of this section emigrated to the Pacific coast.

The mining industry had not fully recovered from the retarding influences of that exodus when the Civil War broke out and put an end to it all for the time being and for many years afterwards. In fact, not until within the last year or two has there been real evidence of a resumption of gold mining in North Carolina on an extensive scale, although there have been spasmodic attempts; but now the indications all point to a genuine, healthy growth of the industry.

So far as we have record, the total value of the precious metals produced up to date, by the mines of North Carolina, amount to $11,817,990. Of this amount $11,754,369 was gold and $63,620 was silver. It is known, however, that this amount is not nearly the whole output of the gold mines of this state—it is more likely to represent less than one-half the true amount. It is known that great quantities of the products of the mines were for years exported directly by foreign companies having headquarters abroad. It would be more nearly correct, geologists here and others in a position to know tell me, to say that the gold mines of North Carolina have turned out at least $25,000,000 worth of the precious stuff, and the late Prof. W. C. Kerr, who for many years was the State Geologist, frequently stated, that in his opinion there was, ten years ago, at least $100,000,000 of gold in the rocks of western North Carolina capable of being profitably mined.

The North Carolina gold is particularly pure and beautiful in color, and there has always existed an active demand on the part of native and other jewelers for North Carolina gold in the manufacture of costly jewelry, in preference to that mined elsewhere.

There are so many gold "mines" in North Carolina that it is impossible here to do more than barely describe a few of the most important and promising.

The writer is under many obligations to the State Geologist, Prof. Joseph A. Holmes, for the use of valuable material secured from him and his office—the gold mining interests of the state having this year commanded a large portion of his time.

Brown Mountain Mine, Burke County.

This mine is located about 12 miles north of Morganton, N. C., on Caney Branch. The mine openings are merely prospects, and consist of two shafts 20 and 25 ft. deep and one small open cut. Shaft No. 2, according to an assay of a sample taken therefrom, shows $15.42 per ton—gold, $12.40; silver, $3.02. This sample was furnished to the State Geologist by the owner, Gen. R. F. Hoke, of Raleigh, President of the Charlotte & Atlanta R. R. Professor Holmes states that a sample taken from the ore dump at the mouth of this shaft by his staff of surveyors this year showed only a trace of gold and 1 oz. of silver. The bed of Caney Branch was washed for gold in former years up to a point opposite the present shaft No 1, and yielded well.

The Redding Mine, Randolph County.

This is one of the most prominent and promising mines in North Carolina. It is at this particular time attracting much attention on account of the operations going on there, and the valuable finds which have been made.

A friend of the writer, who visited this mine within a month, describes it as follows:

> The Redding Mine is about a mile from the railway station at Cedar Falls: It was owned for years by Peter Julian, and during his lifetime was extensively worked for surface gold. Mr. Julian's books show that these mines took out over $75,000 in gold with the crudest kind of hand-rockers. No attempt at shaft mining was made until recently, when Mr. J. W. Lindow bonded this property and placed Mr. Harry Doub, a practical miner, in charge, and he is now sinking three shafts. Two of these shafts have only been sunk 10 or 15 ft. deep. One shaft, however, has been sunk 25 ft., and as far as has been reached, the ore is exceedingly rich. The other two, while not quite so rich, still show ore that will pay handsomely. In mine No. 1 a vein of gold was found near the surface that will mill from $1,000 to $2,000 per ton. This ore grows richer as the shaft sinks deeper. A number of very pretty nuggets have been found in the Redding, one of which weighed 23 pennyweights, the others ranging from 1 to 10 pennyweights. Mr. Lindow is having the shaft sunk deep enough to thoroughly test the ore. If this test proves as satisfactory as it has so far, steps will be taken to mine it on a large scale. An eminent mineralogist has examined this property and will make his report soon.

Cabarrus and Mecklenburg County Mines.

These are two of the principal gold-bearing counties of North Carolina, and there are nearly one hundred mines in each county which have been profitably worked at some time. Few of them are in operation now, not exceeding a dozen. At the Goodman Mine, in No. 6 township, Cabarrus county, work has just been resumed on a small scale. The old Goodman Mine was purchased in July last by a syndicate, and on Aug. 12 the few men put to work at first "struck it rich." Within two days, so the writer is informed, several thousand dollars' worth of gold, in ore and nuggets, were taken out. The vein is said to be the richest ever struck in Cabarrus county.

The value of some of the "old mines" of this state is something deserving special attention. Most of them when they were worked before—or rather "scraped over" by the crude appliances of the early days of mining—were by no means exhausted when work on them was abandoned. With the improved machinery of to-day many of these old mines could be made to pay even better than they did when first opened.

The Reed Mine in Cabarrus county is located ten miles southeast of Concord (the county seat). The first nugget discovered at this mine was in 1799. It weighed 17 lbs.. Four years later another nugget was found, weighing 28 lbs, which is said to have been the largest ever found east of the Rocky Mountains. Regular work on this mine began about 1804 and was prosecuted for a period of about 40 years, during which time the mine yielded large quantities of gold—the proportion of large nuggets (which are still being found occasionally) not being equalled on this side of the continent, according to the State Geologist. The main shaft is 120 ft. deep. The mine was operated in a fitful way from 1881 to 1887, when regular work was discontinued. In 1895, some prospecting was done and the mine has been developed some since. The old shaft has been opened and retimbered, and several openings have been made for placer work. A shaft has been sunk near the western limit of the property which has opened up a large body of low-grade ore that assays at $7.50 per ton in free gold, and $11.55 per ton of gold and sulphurets. Preparations are being made for active mining on a larger scale, the property having changed hands recently.

The Rocky River Mine is situated ten miles southeast from Concord. The last work at this mine was done in the summer of 1895 by Mr. Wayne Darlington, M. E., who prospected the property for some Philadelphia capitalists. Assays of the ore from this mine show $6 to $8 of precious metals per ton.

The Gold Hill Group of Mines.

These are chiefly in Rowan county. The village of Gold Hill is about 15 miles southeast of Salisbury, where the large shops of the Southern Railway system have just been erected.

The group comprises several mines located in a belt of auriferous schists, about 1½ miles long and ⅔ of a mile wide. None of them are now in operation. There are ten or twelve well-defined veins in the district.

The Randolph vein, on the northwestern edge, has been worked for a distance of 1,500 ft. and to a depth of 750 feet. The ore chimneys or shoots are very marked and are three in number, and extend to the lowest depths to which the mine has been worked. In 1856 (when the depth of this mine was 410 ft.) the thickness of the ore body was stated by Emmons to be from 6 ins. to 4 ft., and in one part 7 ft.

The Hunnicutt (one of the veins alluded to above) has yielded $101,665, of which account has been kept. Another, the Troutman, has yielded over $400,000, and has been worked to a depth of over 100 ft. The McMakin was worked to 180 ft. with profitable results, two of the assays in 1894 and 1895 showing silver, per ton, $317.95 and $646.50. The whole of the Gold Hill mines produced over $2,000,000 up to 1856, according to Professor Emons, in a report made some years ago. Up to 1874 the Gold Hill mines had produced an aggregate of $3,000,000 worth of free gold, which has been extracted from the ores, and which represents but 20 to 33% of the assay value of the ores.

The mode of extraction, until 1881, when a 20-stamp mill was erected, was by Chilean mills and rockers entirely. The last regular operations carried on by the New Gold Hill Mining Co. was in 1893 by Mr. Richard Eames and associates, when ores from the Barnhardt vein were worked in a 10-stamp mill near the mine.

Since that time work has been irregularly conducted, mostly by "tributers," who mill the decomposed material from the old dumps of the Barnhardt mill.

Although the Gold Hill ores are sulphuretted, no treatment other than that of simple amalgamation has been attempted, so far, although chlorination has been advised.

State Geologist Holmes states that there are probably still good ore bodies in these mines, and that certainly a careful examination is warranted. Improvements in the metallurgical treatment are advised, viz.: concentration of the sulphurets, after battery amalgamation, and subsequent treatment by a chlorination, cyanide or smelting process.

Some of the other mines in Cabarrus county can only be named as follows: The Mauney, 1½ miles from Gold Hill, which has assayed ores at $2 to $6 per ton; the Rocky River (10 miles from Concord), whose ores have assayed at from $3.17 to $64.59 in gold and $1.04 to $3.66 in silver; the Buffalo, pyritic, $3.50 gold per ton; and the Allen Furr, eleven miles from Concord, the ores of which have assayed at $7.75 to $51.70 per ton.

The Sam Christian Mine.

This mine is in Montgomery county, 12 miles from Albemarle. It has been productive of remarkably fine and large gold nuggets. The gold is found in old "channels" in gravel of a thickness of from 1 to 3 ft., and deeply covered with soil. It is very rarely found in the shape of dust. The nuggets weigh from 5 to 1,000 pennyweights.

In 1888, during 88 washing days 40 nuggets were found weighing 4,200 dwts. The method of work pursued at this mine consists of a removal of the soil resting on the gravel, followed by a very careful washing of the gravel in sluices and rockers. Where the overlay was very slight it was removed by simple digging, and in some cases it was washed away by hydraulic giants. The "harvest" periods were uncertain. Sometimes a few days' work, and often only a few hours', would suffice to obtain very profitable rewards for months of almost un-

productive labor. The above-mentioned 40 nuggets were obtained from 1,070 cu. ft. of gravel.

This mine was operated also in 1893, and water was supplied from a pumping station on the Yadkin River, about two miles distant, the water being conveyed in 20-in. iron pipes.

Other North Carolina Mines.

The Rudsil Mine is one mile south of Charlotte. It is owned by Carson & Miller, of Charlotte, and preparations began a month or so ago to resume work. It will soon again be in active operation. For many years this mine was operated with great success. The ore was carried in pockets in the slates and was the richest and most easily mined brown ore of the region at the surface and for a considerable depth. At a depth of about 200 ft. the free gold largely disappeared. The "middle shoal" or ore body to which this mine chiefly owed its fame, was 100 ft. long and in places 15 ft. thick, composed chiefly of compact iron pyrites. The ore was uniformly of high grade, entire shipments sometimes reaching $180 per ton.

At the St. Catherine Mine, near the eastern end of the Rudsil lode, preparations to resume work are also being made. Mr. Obdyke, of New York, is the owner, and the mine is in charge of Mr. G. W. Pitcher, of Charlotte. This mine has been worked to a depth of 460 ft., but a large ore body is still to be removed between the 370 ft. level and the bottom. Assays of brown ores from this mine show $27 to over $100 per ton in brown ore, $52 to $73 per ton in first-class ore and $33 to $36 in second-class ore. Concentrates yield $40 to $135 per ton.

In 1883 a 10-stamp mill was erected. The ores were first subjected to a preliminary cobbing, which separated out the massive pyrites and lean ore, the latter going to the stamp mill. The free gold was caught in the battery and on the plates in the customary mode of amalgamation, and the tailings led directly to Frue Vanners, where the product was concentrated. The cabbed pyrites and concentrates were shipped north and elsewhere for treatment. The last work at St. Catherine, of which the writer is aware, was in 1887. But, as intimated above, preparations are now being made for a resumption of operations, and on a large and permanent scale.

The work of drawing off the water from the St. Catherine began a month ago, and it will be put in shape for work as soon as practicable. The shaft is now 450 ft. deep.

The deep mines of Montgomery county have been very prominent in the mining history of the state. The most important group is situated in the extreme northwestern corner of the county, in the vicinity of the village of Eldorado.

The Russell Mine is about 3 miles north of Eldorado. It has been worked more extensively than any other, and has, therefore, allowed better opportunity for study.

It is stated that the average ore, embracing the entire material from this cut, milled $2.27 per ton. There were some streaks, from 4 to 5 ft. wide, which went much higher (as high as $9.95), and still others where portions of the ore were so rich that it was carried out in powder kegs. A set of 17 assays show gold all the way from $2 per ton to $332 per ton. A 40-stamp mill in good condition is located on the property. Preparations are now in progress for the erection of a cyanide plant for the treatment of the ores.

The Appalachian (or Coggins) Mine is situated in close proximity to Eldorado. It has large bodies of low-grade ore similar to those of the Russell, yet ores that are easily within the limits of profitable work.

The depth of the last workings was 160 ft. A 40-stamp mill stands on the property. Several assays of the ore show its variation to be similar to that of the Russell.

The Tredwick Mine is 7 miles southeast of Charlotte. It has been prospected to a depth of 80 ft., and for a length of 200 to 300 ft. The vein is 1 to 2 ft. wide, and carries a relatively large amount of copper minerals.

The Ray Mine is situated 9 miles southeast of Charlotte, and is owned by the Baltimore & North Carolina Mining Co. There are five veins with an aggregate length of about four miles. The south vein has been worked to a depth of about 60 ft., and the Phifer Grove vein to a depth of 40 ft. The mine material from both was free-milling brown ore. The Ray Mine, which is the best known of them all, is entered by six shafts, the deepest being 250 ft. The ore seam is 6 to 8 ins. thick and is filled with nearly compact sulphurets. Most of the ore down to the 120-ft. level has been stoped out. Assays show gold ranging $20 to $30 per ton. There are 360 acres in this property.

The Surface Hill Mine, in Cedar Creek township, has long been known for its large yield of nuggets. It is quite certain that several thousand pennyweights must have come from the space of a few square feet.

A considerable amount of brown ore of good appearance, carrying copper sulphurets, has been mined in the process of hunting for nuggets, but as an ore it is of little value, despite its fine appearance. Assays show but $2 to $3 per ton.

Some Minor Mines.

The Stephen Wilson Mine is nine miles west of Charlotte. The property comprises 340 acres, and it is stated that ten well-defined veins have been located. Of these only two have been worked, namely, No. 2 and No. 3. No. 2 vein was entered by an underlay shaft to a depth (on the incline) of 400 ft., and four levels run. The ores carry iron and copper pyrites. Some very rich ores have been mined, showing assays of $25 to $345 per ton.

The Todd Mine is situated five miles northwest of Charlotte. It has been penetrated to a depth of 80 ft. Some exploratory work was done at this mine in 1886, and a 10-stamp mill erected.

The Black Mine, ten miles east of Charlotte, has a small, but very rich vein of brown ore, of which assays show values from $50 to $236.

The Copper Knob (or Gap Creek) Mine is situated in the southern part of Ashe county. A shaft was sunk to a depth of 60 ft. with satisfactory results, and subsequently deepened (as reported) to 140 ft. At this stage the mine became the prey of a company of speculators. The concurrent testimony of many persons cognizant of the last work is that the resources of the mine continued good as far as the explorations extended. Assays show $10 to $123 per ton of precious metals.

In the region west of the Blue Ridge are several gold mining localities, some of which have attracted attention, and have been the site of more or less productive work.

South Carolina Gold Mines.

There are quite a number of valuable and profitably worked gold mines in South Carolina, but this article will deal with only two of them, located in the two counties of Chesterfield and Lancaster.

The largest and probably the best known of these mines is the Haile, located three miles from Kershaw. This mine has been in profitable operation for a number of years. It is now owned by a company of which Mr. G. H. Seeley, of New York, is president; Mr. A. T. Cross, of New York, is secretary and treasurer, and Mr. A. Thies, general manager.

The chlorination process is used and the mine is equipped with modern machinery, costing over $50,000. The Haile is the largest gold mine in operation east of the Rocky Mountains.

About 150 miners are regularly employed, all negroes except the foremen. The exact figures are not obtainable, but the report is that the monthly product of this mine is from $7,000 to $20,000, the annual product therefore being somewhere between $100,000 and $200,000. The labor employed is cheap—much cheaper than that employed in western mines—and the profits of the company therefore relatively much greater than those working western mining property.

The Brewer Mine, in Chesterfield county, is operated now by the De Soto Mining Co. The chief owners are the widow of the late Senator Hearst, of California, and Mr. E. Mots, the latter being the superintendent and general manager of the company. The president of the company is also a New Yorker, Mr. Irwin C. Stump, as is also the secretary and treasurer, Mr. H. B. Parsons. C. A. Clark, of San Francisco, is vice-president. The Brewer Mine is equipped with modern machinery, which at present has a capacity of 200 tons of ore per 24 hours. The ore averages $3 of gold per ton. It is the intention to enlarge the capacity of the plant to 2,000 tons per day. The supply of gold-producing ore is said to be almost inexhaustible. The ore body now being worked is 2,500 ft. wide and 1½ miles long. The open shaft is 500 ft. in diameter and 200 ft. deep, and the tunnel leading into the mine is 475 ft. long. This mine also uses the chlorination process.

VALVE BOX AND CAPSTONE USED ON THE WATER-WORKS OF SYRACUSE, N. Y.

The valve boxes and capstones for the same, used on the Syracuse water-works in 1895, are shown in detail by the accompanying illustrations. Two classes of valve boxes were used, different only in the size of their lower portions, as shown.

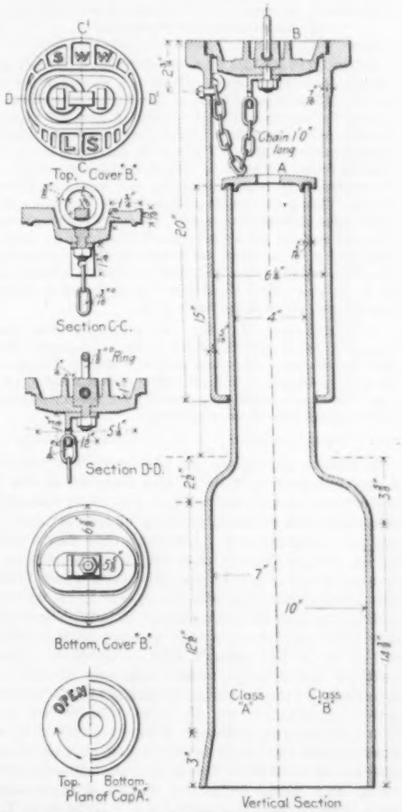


Fig. 1.—Details of Valve Boxes Used at Syracuse, N. Y.

The valve boxes were made by the Jackson & Woodin Mfg. Co., of Berwick, Pa., after the design furnished by the Syracuse Water Board, as shown herewith, and the contractor for the capstones was Mr. John Crabtree, of Syracuse. The

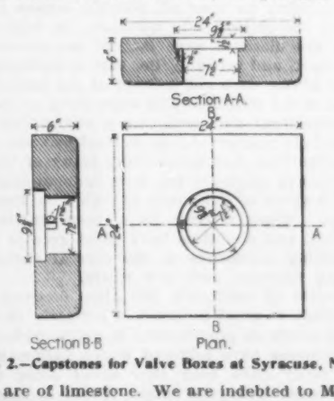


Fig. 2.—Capstones for Valve Boxes at Syracuse, N. Y.

caps are of limestone. We are indebted to Mr. W. R. Hill, M. Am. Soc. C. E., Chief Engineer of the Syracuse Water Board, for the information and illustrations given.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Published every Thursday at Tribune Building, New York. Entered at the Post Office, New York, as Second Class Matter.

D. McN. STAUFFER, CHARLES WHITING BAKER.....EDITORS.
WM. KENT, E. E. R. TRATMAN, M. N. BAKER, CHAS. S. HILL, A. B. GILBERT.....ASSOCIATE EDITORS.
CHAS. W. REINHARDT.....CHIEF DRAFTSMAN.

GEO. H. FROST, F. P. BURT.....BUSINESS MANAGERS.
ALFRED E. KORNFELD, New York.....
F. A. PECKHAM, Chicago.....ADVERTISING REPRESENTATIVES.

PUBLICATION OFFICE.....Tribune Building, New York.
CHICAGO OFFICE.....1636 The Monadnock.
LONDON AGENCIES: KEGAN PAUL, TRENCH, TRUEBNER & CO. (Limited), Paternoster House, Charing Cross Road; SAMPSON LOW, MARSTON & CO., (Limited), St. Dunstan's House, Fetter Lane.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; 6 months, $2.50; 2 months, $1.00; Single copies, 15 cents. To all other countries in the Postal Union, add $2.08 per annum (4 cents per number) to above prices for postage. No club rates allowed. Mailing addresses may be changed at will by sending both old and new address. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 326 means that subscription is paid to the 32d week (that is the issue of Aug 6) of the year 1896; the change of these figures is the only receipt sent, unless by special request.

ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes to standing advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

Irrigation enterprise in the west will receive a new impulse in view of the decision of the U. S. Supreme Court, outlined in our news columns, upholding the constitutionality of the Wright Irrigation District Law. Although this was a California statute similar ones had been passed by a number of other states, and doubtless other Western commonwealths will be encouraged by this decision to take the same step. Briefly, these acts give land-owners corporate powers under which money may be raised, and irrigation works built at the general public expense, instead of requiring the land-owners to buy water from irrigation companies, or to form themselves into such private corporations. A large number of irrigation districts have been formed in California, millions of dollars of bonds issued, millions more voted, and many irrigation works of magnitude have been carried out under the Wright law. The districts have been harried from the start by litigation, but the California State courts have invariably, if we are correctly informed, upheld the Wright law. Nevertheless, the legal opposition has had a depressing effect on the district bonds, and the depression has doubtless been increased by bringing to bear all possible means to discredit the securities in question. In addition to this, the districts were largely experimental at the start, and probably the best engineering and legal advice were not secured at the inception of some of the districts. The importance of the best possible legal and engineering advice has been more fully realized of late, at least by some of the organizations, and accordingly many of the districts have employed the most eminent engineers and lawyers of California to report on their districts. These reports have been handsomely printed, and doubtless have aided greatly in establishing confidence in the several enterprises among financial men and others.

Outside of California, irrigation districts have not made so great progress, or certainly have not come nearly so prominently to public notice. The other states have followed where California led, and many have been slow about doing so, in some cases with good reason, it may be assumed. Recently, all, or nearly all, enterprise of this sort has been at a halt, awaiting the decision which has just been made. Now that the U. S. Supreme Court has so firmly sustained what the California courts vigorously and continuously upheld for many years, irrigation enterprise may be expected to take new life; bonds will be sold readily and much irrigation work may be expected. While the legal questions have been in suspense, the practical questions of operating the districts and their works have doubtless been satisfactorily answered, in very many cases, the economical development, distribution and application of water to crops has been advanced and the people of many new sections have come to appreciate the advantages, and often the necessity of providing an artificial water supply. At the same time, the small farm idea, for many products, has developed. Altogether the future of irrigation seems to be much brightened by the decision. Some of the irrigation companies may not be pleased by it, but many will find increased markets for their water in bulk, districts buying their whole supply from a company, as is already practiced, thus relieving the companies from many petty details and conflicts seemingly inherent to the distribution of water by corporations. At the same time, not all sections will adopt the district system, even if they might, and the general stimulus given to irrigation will, in such sections, be wholly to the benefit of the companies.

We print on another page of this issue an interesting account of the present status of gold mining in North Carolina. There is no doubt that gold exists in the Appalachian range in various parts of the Carolinas, Alabama and Georgia, and it is possible that these states may yet figure largely as producers of precious metals. In a recent issue of the "New York Financier," a correspondent calls attention to the fact that the mines of the Rand district in South Africa, the most profitable in the world, produce low-grade ores almost entirely, yielding only $2.50 to $20 per ton, and require treating by the cyanide process, or chlorination, and continues:

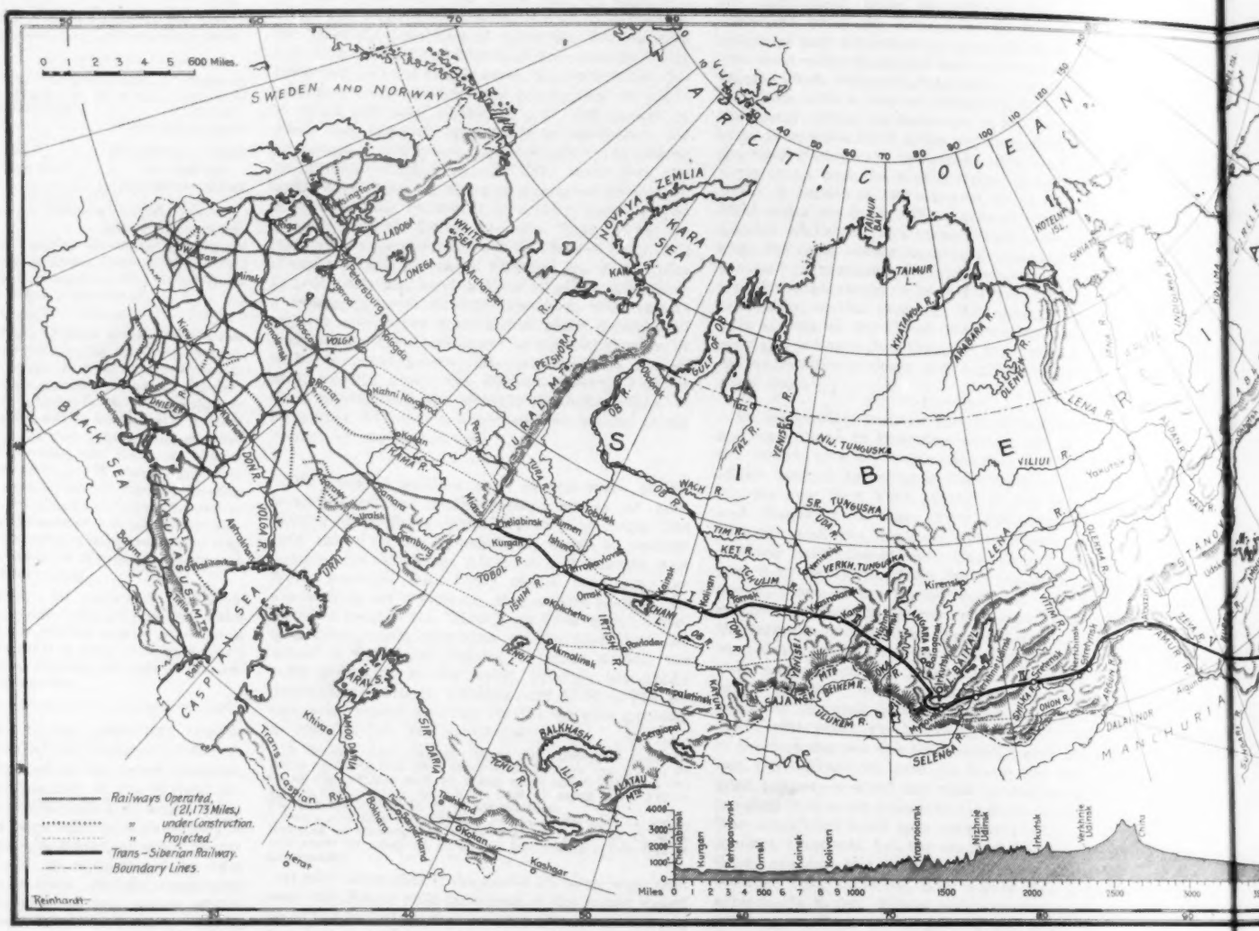
> In Georgia and Alabama there are miles and miles of veins carrying free gold from $2 to $20 per ton within 40 ft. of the surface and as many more miles carrying the quartz that contain sulphurets and by assay show $10 to $75 per ton within 75 ft. of the surface.
>
> There are also large bodies of low grade ores in disintegrated or decomposed veins that are 10 to 40 ft. wide and show by assay $1 to $5 per ton within a few feet of the surface.

It may seem that if the above showing were correct, the future gold bonanzas of the world would be in the mountain regions of the Southern States; but the remarkable characteristic of the South African deposits is the uniformity with which the gold is distributed through great masses of gold-bearing rock. Does this condition also exist in the gold mines and gold prospects of the South? If it does, and if an extensive system of sampling and assaying can establish this for any given mine, its value as a gold producer is beyond question. We have never seen, however, authentic testimony that this is the case. On the contrary, our information is that the gold bearing veins in the Southern rocks are usually of small width, or if of large size carry paying ore in only a small part of their width. However, if large bodies of low-grade ore with average contents high enough to be profitable exist in the South in connection with any of the various prospects, the fact ought not to be difficult to establish.

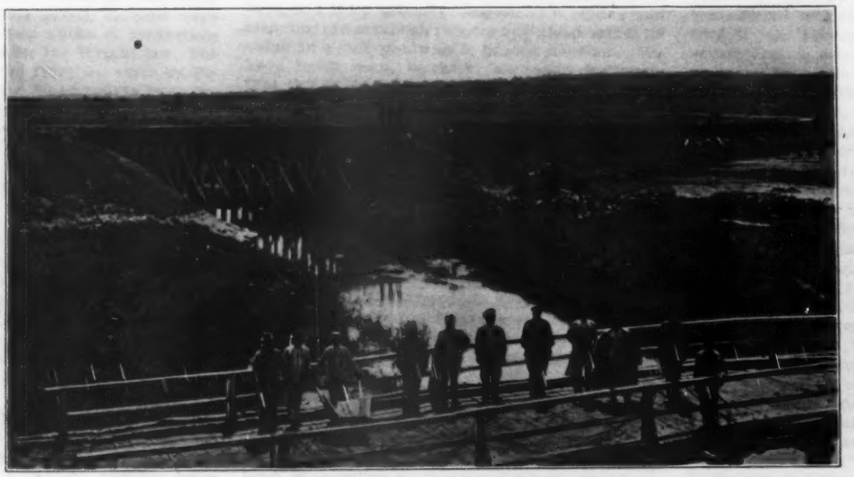
We may remark in this connection that the gold deposits of the Southern States have been most thoroughly discussed in various papers read before the American Institute of Mining Engineers. We would advise any of our readers interested in the subject and desiring more information concerning it to consult the "Transactions" of this society.

A remarkably fast train service now being regularly made on the Great Western Ry., of England, is recorded in another column. The train runs from London to Exeter, 194 miles, without a stop, in a schedule time of 3 hours 45 mins., or at an average speed of 51.7 miles per hour for the entire run. Water is taken at the track tanks. The line has generally easy grades and curves, broken, however, at Bath and Bristol by sharp curves which have to be passed at reduced speed, while there are some grades of 1.23 to 1.10%, each a mile long, and longer grades of 0.8 to 0.67%. The weight of train, consisting of six corridor cars mounted on trucks, is about 413,600 lbs. In our issue of Sept. 19, 1895, we discussed at some length the high-speed train records of English and American railways, and gave the details of the make-up and schedules of some of these trains. The most noted American train is undoubtedly the Empire State Express of the New York Central R. R., which, with a load of about 377,000 lbs. behind the tender, makes its daily run of 440 miles at the average speed of 50.76 miles per hour, or 52.17 miles per hour if stops are deducted. This train makes three stops, and the first division of its run, 143 miles, is passed in 165 minutes, or at the rate of 52.31 miles per hour. The railways running from London northward are those which have hitherto done the most showy running in competitive racing and in regular schedules, while the western and southern railways have for years had a bad reputation in this respect. The present remarkable service on the Great Western Ry., however, seems to indicate that that line is returning to the old aggressive position and high standing of its early days.

An interesting damage suit was decided in the Supreme Court in Brooklyn on Oct. 28, in which the widow of a workman obtained a verdict for $6,000 against Levering & Garrigues, contractors for the new New York station of the New York and Brooklyn Bridge. The workman was a painter, and the scaffold upon which he was working fell to the ground. The scaffold was supported by two hooks from the eaves of the building, and one of the hooks broke. It was proved on the trial that the foreman of the painters asked the foreman of the structural work for some iron to make a hook, that the latter selected two tie rods, each about 5 ft. long, which had been used to tie the floor beams of the old structure; the painter's foreman gave a sketch to the blacksmith who made the hooks as directed. Neither of the foremen nor the blacksmith tested the iron but the blacksmith said he knew the iron was good because it stood the work he put on it while bending it at a red heat into the form of the hook. The completed hook also was not tested in any manner whatever, but the scaffold was hung with it one evening and the men went to work on the scaffold next morning, and within five minutes afterwards it fell, killing one man and seriously injuring another. It was proved that when the tie rods were put into the old structure, 12 or 14 years ago, they were obtained from reputable manufacturers under rigid specifications and inspection, but the fractures of the iron showed it to be extremely bad, so bad indeed that no testimony was offered to show that it was good; but only that it was presumably good on account of its source and on account of the blacksmith's judgment upon it while he was working it. The whole case was a good illustration of how builders, foremen, blacksmiths, painters, and in fact almost everyone have the universal habit of "taking things for granted" in regard to the strength of materials and of structures. Because the iron had been used in a building it was taken for granted that it was good iron originally and that it had not deteriorated during its 12 years of service; it was taken for granted that the shape and dimensions of the hook were sufficient, although the shape was somewhat unusual; it was taken for granted that the blacksmith knew his business and would not burn the iron while working it; the blacksmith seems to have known nothing about making a cold bending test of the iron to determine whether it was good or not, but assumed that if it stood bending hot it could not fail to be good. The boss painter took the completed hook as being all right, as a matter of course, and made no attempt to test it, although he had ample opportunity, and the workmen, as workmen always do, took the judgment of their foreman that the scaffold was all right. If either of the two foremen or the blacksmith had any suspicion as to the quality of the iron, their doubts could have been resolved by a cold bending test which they could have made in five minutes; but not one of them seems to have had any suspicion whatever.



MAP OF RUSSIA SHOWING ROUTE OF TRANS-SIBERIAN RAILWAY, THE RAILWAY LINES OF EUROPEAN RUSSIA, AND PRINCIPAL RUS
(Drawn From an Official Map Published by the Russian Department of Trade and Manufacture.)

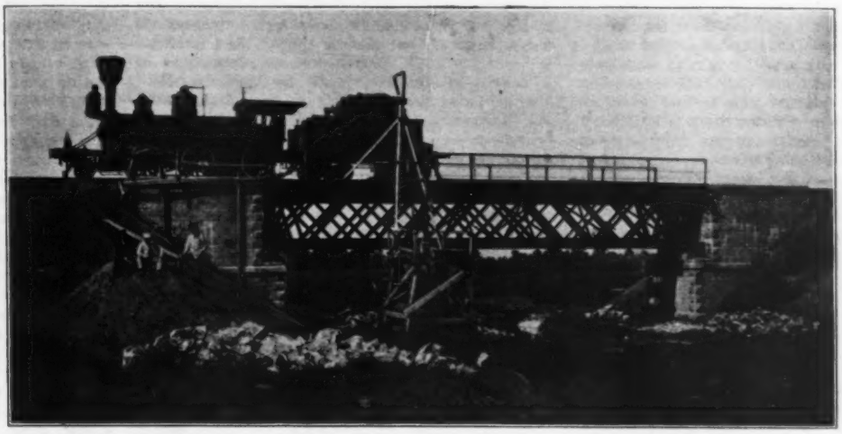


A SUMMER VIEW ON THE TRANS-SIBERIAN RY.

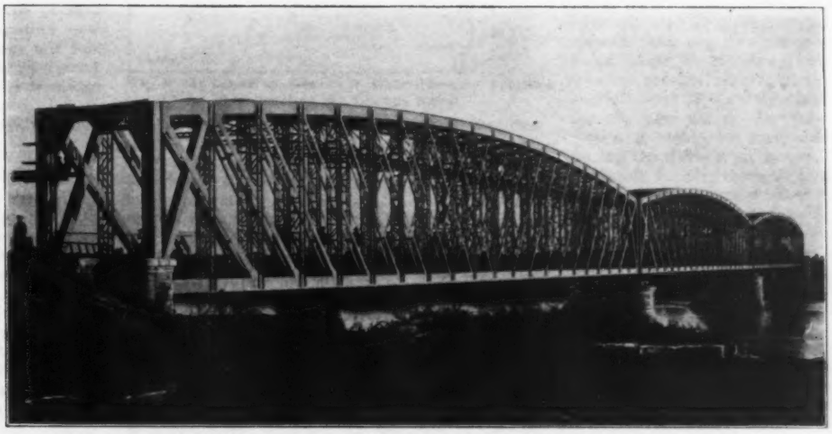
A TYPICAL L

THE LONGEST RAILWAY

RINCIPAL RUSSIAN CITIES.



LOCOMOTIVE AND DECK TRUSS BRIDGE, TRANS-SIBERIAN RY.



RIVETED TRUSS BRIDGE OVER THE USURI RIVER TRANS-SIBERIAN RY.

TYPICAL LOCAL STATION ON THE TRANS-SIBERIAN RY.

MASONRY CULVERT AND HIGH EMBANKMENT, TRANS-SIBERIAN RY.

AILWAY LINE IN THE WORLD.

The lesson of the accident is, do not "take things for granted," but it will be heeded by but the few who happen to hear of such accidents. The great majority of foremen, blacksmiths and the public at large will continue to take things for granted as long as human nature is what it is.

The incident is also an illustration of the risk which every large employer of labor runs of seeing a good slice or the whole of his profits from a piece of work absorbed by damage suits on account of accidents to employees. The law is clear that the employer of labor is charged with a responsibility for the safety of his workmen; and motives of self-interest as well as motives of humanity impel toward the most careful provisions for their safety. In addition to this it is the practise of most contractors and many manufacturers nowadays to carry insurance against losses of this class in some of the various casualty companies. Even the most painstaking vigilance cannot prevent occasional serious accidents, and it is as wise to make provision against exceptional losses of this sort as it is to make a similar provision against losses by fire.

We commend this incident also to the few engineers who still hold to iron as a safer metal than steel for structural purposes. A hook which breaks off short under a static load is certainly pretty poor metal and will well match all the stories that are told of unaccountable failures of steel from "crystallization," etc. Engineers are well agreed that structural steel of the present day is a safer material than the product now turned out from the puddling furnaces; but this occurrence illustrates the fact that more than a dozen years ago iron of very bad quality was also made and found its way into structures of such importance even as the Brooklyn Bridge terminal station.

Louis Baldwin Howell, M. E., died in Chicago, Ill., Nov. 12. He graduated from the Sibley School of Cornell University in the class of 1895, and during his senior year was the managing editor of the "Sibley Journal of Mechanical Engineering." A short time after his graduation he became a member of the staff of Engineering News, but was obliged to resign his position in December, 1895, on account of an affliction of the lungs. The remainder of the winter he spent at Eddy, New Mexico, but the climate there did not effect the cure that was hoped, and the last months of his life were spent at his home in Chicago.

Mr. Howell was a young man of remarkable abilities, and although a member of the staff of this journal for a few months only, he proved himself possessed of talents that justified hopes of the highest success in his profession. During his stay in New Mexico he prepared articles for this journal, of which one on "The Thompson-Ryan Dynamo" was published in our issue of March 12, and another describing the extensive works of the Pecos Irrigation & Improvement Co., at Eddy, was published Sept. 17.

By his attractive personal qualities and his excellent character he won the friendship and esteem of all those with whom he was associated, and the news of his untimely death brings to all his many friends the sense of a personal loss.

A SURVEY OF A GREAT LAKES AND HUDSON RIVER SHIP CANAL.

The position of this journal on the proposal to construct a ship-canal from the Great Lakes to the Atlantic Ocean is well known to our readers. We believe that the current estimates of the great profits and public benefits of such an enterprise are absolutely unreliable because the information is nowhere available from which accurate estimates can be made, either of the cost of the work or of the traffic which would use it. Further, none of the various advocates of the enterprise have seemed to us to take a really broad and comprehensive view of all the conditions of the problem. The steady reduction in the cost of carrying bulk freight by rail, for example, seems to be persistently overlooked.

Nevertheless, we appreciate the fact that a great number of people, including many prominent members of the engineering profession, are enthusiastic over the possibilities, or probabilities, as they consider them, of "a deep waterway from the Great Lakes to the Atlantic;" and because the information available is so limited, it is as difficult to prove that their expectations can-

Map of the Canals of New York State, Showing Proposed Ship Canal on the Oswego Route.

not be realized as it is for them to show that they are well grounded. Vague guesses are not engineering estimates; and before the ship-canal enterprise will deserve to receive the support of either private or public capital on the one hand, or to be definitely laid on the shelf on the other, the actual facts concerning the enterprise ought to be ascertained and made public.

The most important part of any such investigation, it appears to us, is the ascertaining of the traffic which a ship-canal over any of the various routes could secure. It ought to be first known with some accuracy what benefits will result from a proposed work before the actual planning and estimating of its cost should proceed very far. In this ship-canal scheme, however, there is a noticeable tendency on the part of its promotors to gloss over with glittering generalities this part of the investigation, and devote attention solely to the engineering questions respecting the most available route and the cost of the work.

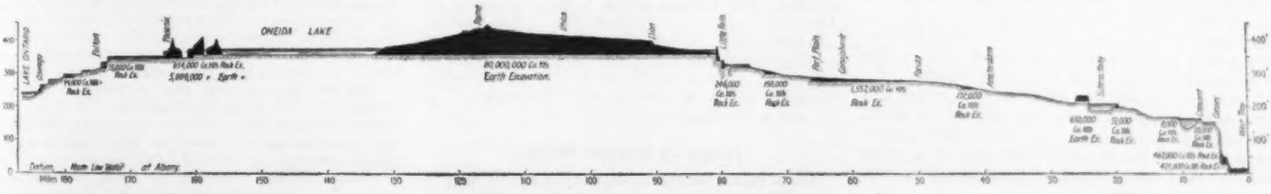
Information in this field also, however, is exceedingly meager. No survey that is worthy of the name has ever been made of any of the proposed deep waterway routes, and the estimates of cost, therefore, have been more or less of the character of guesses. In the last annual report of the State Engineer of New York, however, we find a report by Mr. Albert J. Himes, Assoc. M. Am. Soc. C. E., Resident Engineer on the Eastern Division of the New York State Canals, of a "hasty reconnoissance" made by him for a 20-ft. deep waterway from Lake Ontario to the Hudson River. As no special fund was available for the work, it was done "in such odd moments as could be snatched from the routine work of the division." The data was obtained largely from papers in the Am. Soc. C. E. Transactions, the files of State Engineer reports, the maps of the Geological Survey, and other published matter, supplemented by cross-sections taken with the stadia. It is manifest that data secured in such hasty manner are hardly a safe reliance on which to base final opinions concerning an $80,000,000 enterprise. Nevertheless Mr. Himes' survey does offer something tangible in the place of the previous lack of knowledge, and we have, therefore, thought it worth while to present his principal facts and discuss his results in this place.

It is fair to say at the outset that Mr. Himes disclaims any great accuracy for his estimates, and states that they must be considered as preliminary, and as only valuable as a means of determining the advisability of making a complete instrumental survey, when the necessities of canal improvement require such a radical change in the present canal system as is here contemplated.

The proposed location is between Troy, on the River Hudson, and Oswego, on Lake Ontario, a distance of 182½ miles. The plan contemplates slack-water navigation of the Mohawk River by dams and locks to Rome, and the utilization of Oneida Lake and the Oswego River, on the general route suggested by the late State Engineer Elnathan Sweet, in his paper presented to the American Society of Civil Engineers in 1884. The estimates cover a canal 100 ft. wide on the bottom and 20 ft. deep, with locks 450 ft. by 60 ft. The proposed maximum lift of a common lock is 27 ft.; a lift seemingly warranted by the locks at Sault Ste. Marie and other points.

Concerning the important question of water supply to the summit-level, the estimates are based upon the emptying of each lock every 30 minutes, with evaporation and leakage duly considered. The required maximum amount, on this basis, would be 36,000 cu. ft. per minute; and of this the present 33,000 cu. ft. per minute on the summit-level of the Erie canal would be available for the new canal. As this is mostly stored water, it would be independent of the rainfall during the navigation season. To supplement the available supply, there is a drainage area above the proposed summit-level of 1,972 sq. miles, which Mr. Himes believes can be depended upon for a flow of 27,240 cu. ft. per minute, which, added to the present supply would be equivalent to 60,240 cu. ft. per minute. Oneida Lake would also be used as a storage reservoir to a 10-ft. depth; and as this lake has an area of 81 sq. miles, and allowing 1 ft. for evaporation, the remaining 9 ft. would furnish a flow of about 67,000 cu. ft. per minute continuously for seven months. Mr. Himes thus deems the sufficiency of a summit-level water supply as absolutely unquestionable.

In the matter of excavation the ultimate cost will depend largely upon the character of the material encountered, and in this connection Mr. Himes notes that by the conditions imposed he was compelled to depend upon surface indications alone. The most serious cutting is in the summit between Little Falls, on the Mohawk, and Oneida Lake, a distance of about 45 miles. The contents of this cut is estimated at 80,000,000 cu. yds. of earth at 25 cts. per cu. yd.; but Mr. Himes says that while this price on the Chicago drainage canal covered the handling of some very hard material, if the material actually found here were rock, the cost of its removal would be prohibitory. After discussing the dams required on the Mohawk and Oswego Rivers, the nature of the locks and the question of land damages, the following estimate is submitted for the total cost of an enlarged canal between Troy and Oswego:



PROFILE OF PROPOSED OSWEGO SHIP CANAL.

86,519,000 cu. yds. earth excavation, at 25 cts.	$21,629,750
3,873,000 " " rock excavation, at $1.00.	3,873,000
18 dams, average cost $376,278	6,773,000
518 vertical ft. locks at $40,000 per vertical ft.	20,720,000
65 bridges	1,750,000
Slope protection	5,188,757
Land damages	3,218,263
	$63,152,770
Engineering and contingencies, 30%.	18,945,831
Total	$82,098,601

Mr. Himes sums up the merits of the proposed scheme as follows: By using slack-water navigation, there is deeper water at the lower end of each level, owing to the slope of the river bed, and out of 182½ miles of canal, 33.4 miles, or 18% of the whole, and including Oneida Lake, will have a depth of at least 25 ft., making navigation that much easier and safer. The width of the waterway is also greater than the typical canal sections for 73% of the entire distance, and the easier displacement of water will permit greater speed than in a narrow canal. New water powers of great value would be created; the removal of the present Erie canal from cities and towns would result in great gain in property values, and the land abandoned by the old canal would be worth much money to the State, though this is not used to offset land damages in the estimate. The engineering problems, while great, are capable of solution; and the chief difficulties in the way are the great cut through Rome, the control of the floods on the Mohawk and the operation of the proposed elevator locks. Mr. Himes deems his estimates rather above than below the actual cost of the work, and he believes that the result of his investigations are favorable to the route and warrant a more exhaustive study.

The most striking feature in the plan is the great summit-level cut, some 45 miles long, and averaging about 50 ft. in depth. Mr. Himes confesses that if this material were rock, its cost of excavation would be prohibitory. The possibility is suggested, however, that by using a higher summit-level and more locks it would be possible to greatly reduce this excavation. It is true that doubts then arise concerning the sufficiency of the water supply for the summit-level, but Mr. Himes points out that inclines or elevators might be designed for transferring boats to the summit-level which would use much less water than an ordinary canal lock.

But a more important question respecting the Oswego route than that of mere quantities and cost is the fact that a 20-ft. waterway over this route would only furnish a part of the proposed connection between the Atlantic seaboard and the Great Lakes. To the estimated cost of this link in the line would have to be added the deepening of the Hudson River for at least 30 miles, to secure a depth of 20 ft. of water, and also that of a 20-ft. canal between Lakes Ontario and Erie overcoming a difference in level of 326 ft. Mr. L. E. Cooley, at the late Deep Waterways Convention, estimated the cost of a new ship-canal, on the American side of the Niagara River, at $23,000,000. What the improvement of the Hudson River would cost for the 30 miles in question can not be definitely stated; but as a harbor has to be formed also at Oswego, the cost of which is not included in Mr. Hime's estimate, it is safe to say that the 20-ft. waterway from Lake Erie to deep water in the Hudson River by way of Oswego would cost not less than $125,000,000.

This is $75,000,000 less than the sum which has been commonly named as the cost of a 20-ft. channel over the present line of the Erie canal; but it is to be remembered that this is a pure guess, so that the comparison must be taken only for what it is worth.

We said at the outset that the economic advantage of the canal was a far more important question than the matter of its cost. Mr. Hime's report devotes one paragraph to this and we copy it verbatim as follows:

> In discussing the economy of building such a waterway, it would be well to consider the history of the Suez Canal. That canal cost in round numbers £20,000,000. To-day the profits of the canal have been so enormous that its stock is worth £80,000,000. But the traffic passing through the Detroit River to-day is not only greater than any traffic that ever passed through the Suez Canal, but greater than the traffic passing through any other single channel in the whole world. This traffic is mainly domestic and is carried on almost wholly between Chicago, Duluth and the upper lake ports on the one hand, and Cleveland, Buffalo and the lower lake ports on the other. Such being the present condition of traffic, what might we expect if the same waterway were extended to connect Albany, New York, Brooklyn, Jersey City and Philadelphia with Buffalo, Cleveland, Detroit, Milwaukee, Chicago and Duluth? We need not consider the possibility of trans-Atlantic shipments from Duluth, but only the extension of our domestic commerce.
>
> Turning now to the military aspect, it is idle to say that no war will ever come between this country and Canada, for the history of the world for all time is a succession of peace and war of varying duration. We hope it may not come; but if it does come, and the vast commerce and the wealth of the lake cities is unprotected, then may Heaven save us, our own hasty efforts cannot.

It appears to us that Mr. Himes is attempting a comparison between two things which are very dissimilar. The alternative to the use of the Suez canal is an ocean voyage around the continent of Africa. The alternative to the use of any Great Lakes and Hudson ship-canal would be the use of some other one of several different routes almost and perhaps quite as economical as the proposed ship-canal.

The railway lines to tide water are carrying freight cheaper every year. They have proved their ability to compete with the present Erie canal, and what is there to show that economies and improvements in railway engineering have come to an end? The Canadian waterway to the sea, by way of the St. Lawrence and Montreal, is being rapidly improved and is to be still further developed by the expenditure of large sums of money. Again, the class or type of vessel has yet to be devised which is adapted to a combined lake, canal and ocean service, if the voyage is to be made without breaking bulk. Barge transportation, in tows on the present waterways, is also in the development stage, and there is good reason to believe that it may prove more economical than transportation by vessels of deeper draft.

As for the "military" uses of a ship-canal across New York State, on which Mr. Himes lays such stress, it reminds us of a story of a peaceable and law-abiding wolf, who barricaded his den when he went to sleep for fear a lamb who lived next door would come in during the night and eat him up.

Seriously, in the highly improbable event of hostilities between Great Britain and the United States, land forces would occupy Canada and would permanently wreck the locks on the Canadian canals with a few well-placed charges of dynamite, long before any of the lighter craft of the British Navy, which alone could ascend the canals, could reach this side of the ocean.

It is fair to say, of course, that this aspect of the scheme was not properly within the scope of Mr. Himes' work. His task was to examine the feasibility and cost of a ship-canal on the Oswego route, and it appears that with the means at his disposal he accomplished wonders. His work should be given careful consideration in weighing the merits of different deep-waterway routes to the seaboard, when it is settled that such a waterway is "worth while."

LETTERS TO THE EDITOR.

Thenard Movable Dam.

Sir: In Executive Document No. 78, House of Representatives, 42d Congress, 2d Session, will be seen about the fullest presentation of movable dams to be found in print. The Thenard system is there illustrated and described.

Yours truly, J. S. Walker.

Engineer Office, U. S. A., Nashville, Tenn., Nov. 9, 1896.

(We do not know whether this document is on sale; but enquiry made of Mr. F. A. Crandall, Superintendent of Documents, Washington, D. C., will settle that point.—Ed.)

Patents on Hydraulic Dredges.

Sir: In your issue of Oct. 29, I notice a letter from the New York Dredging Co., by H. S. Wood, concerning a dredge that company is building for the Mississippi River Commission, in which there occurs the following:

> One special feature of the design is that it is so far different from all usual arrangements of suction dredges with mechanical excavators, as to be entirely outside of the principles claimed by A. B. Bowers as his invention.

I thank Mr. Wood for this admission that "all usual arrangements of suction dredgers with mechanical excavators" are WITHIN "the principles claimed by A. B. Bowers as his invention," or in other words, within the claims of the Bowers Letters-Patent.

As I have twelve U. S. Letters-Patent containing in the aggregate 389 claims, it is perhaps not surprising that he should have failed to notice many of these as, for instance, among others bearing directly on the design referred to, the 14th claim of Letters-Patent No. 411,183, which is as follows:

> 14. In combination, a suction pipe and a rotary excavator secured to the mouth thereof, said excavator being provided with cutting edges or blades, and having its axis outside of and transverse to said pipe.

Until the courts have thus limited this and other claims, it is a bold assertion that the design of the dredge referred to "is outside of the principles claimed by A. B. Bowers, as his invention."

Conceding that he may have inadvertently overlooked the claim cited and many others, is it not strange, in view of his connection with the pending litigation, that he should also have overlooked the fact that Col. Von Schmidt, Williams and Bixler, the McNee Bros., the Golden State & Miners' Iron Works, and others, have been for several years under perpetual injunction not to use claim 25 of my Letters-Patent No. 318,859, which reads as follows:

> 25. A discharge pipe consisting of a series of sections flexibly joined together and supported by floats, in combination with a dredger having a rotary excavator.

Perhaps it may be of interest to note in this connection that in settlement of various suits against infringers of my patents I have acquired the entire right to the Ansell, Lynch, Brown, Hobart (Atlas and Hercules), Letters-Patent; and to the Von Schmidt Letters-Patent also, except as to a one-half interest on the Pacific Coast and the right to, I think, four other states—eighteen Letters-Patent besides my own; and that the Bowers Pacific Dredging Co., of San Francisco, the Bowers Dredging Co., and the Bowers Gulf Dredging Co., of Chicago, the Bowers Hydraulic Dredging Co., of Camden, N. J., and myself, also, are protected by all 30 of the Letters-Patent owned by me with their 450-odd claims.

Respectfully yours,

A. B. Bowers.

Great Northern Hotel, Chicago, Nov. 13, 1896.

P. S.—Since writing the above, Judge Hanford has granted a preliminary injunction against the New York Dredging Co., restraining it from infringement of my patents in the suit of Bowers and the Bowers Dredging Co. vs. The New York Dredging Co., in the U. S. Circuit Court for the Western District of Washington. —A. B. B.

Specifications for Water-Tube Boilers for the St. Louis Water-Works.

Sir: In answer to your editorial reply to my letter of the 7th inst., permit me to say that I adhere to my position "that—within reasonable limits, of course—it is absolutely immaterial whether the bidder furnishes 1 or 50 sq. ft. of heating or grate surface to do a given amount of work." It is assumed, of course, that proper precautions will be taken to insure that the contractor must comply with the requirements of the specifications as to efficiency, capacity, dryness of steam, and smokelessness.

You ask what my advice to a client would be in a case where two bidders, offering boilers "of identical construction," ask practically the same price, the one, however, giving nearly 50% more heating surface than the other.

In a public letting by a municipality, the decision must be in favor of the lowest bidder, who complies with the specifications, the additional heating surface not being entitled to consideration. In the case of a private corporation, however, my recommendation would unquestionably be in favor of the bidder furnishing the most heating surface, other considerations being equal.

Your question, however, does not cover the point at issue. As a matter of fact no two water-tube boilers in the market are "indentical in construction." Most of them differ widely, both in general design and in detail. It is no more proper, therefore, to compare them solely on the basis of heating surface, than it would be to make a similar comparison between the old type of cylindrical boiler and the modern return tubular. Differences in design and detail unquestionably affect the amount of work which can be done by a square foot of heating surface.

Without entering into this controversy further, it would seem to a disinterested outsider that in the matter of proportioning heating surface to capacity, the different boiler-makers—at least those of long standing and experience—should be credited with using ordinary good business judgment. It does not seem reasonable that one manufacturer could continue to sell his type of boiler year after year at a low rating of heating surface per horse-power without being sure of his ground; nor that another would continue to give a different type of boiler a greater allowance of heating surface unless he deemed it necessary to do so. The builders of boilers themselves should be, and I think usually are, very good judges of what can be done with their boilers. So many trials of capacity have been made, and they are so readily made now, that there can be no excuse for either ignorance or deception in this matter.

If your question were asked me on the basis of boilers not "identical in construction"—as would always be the case—I should study the differences, and endeavor to form a conclusion as to the value of a square foot of heating surface in each case. This would reduce the problem to one of relative ability to evaporate water, and on this I would base my recommendations.

Very respectfully,

William H. Bryan,
M. Am. Soc. M. E.

St. Louis, Mo., Nov. 14, 1896.

(Our question was intended to "cover the point at issue," for we understood that the two boilers referred to were of identical design, viz.: the Heine and the O'Brien, but that they differed in

the amount of grate surface and heating surface offered by each as the equivalent of a horse-power. It would be unprofitable to continue the discussion further, for we see no probability that the differences of opinion between ourselves and Mr. Bryan can be reconciled. There are some new questions raised in Mr. Bryan's present letter, however, on which we may comment. That boiler makers of long standing and experience use "ordinary good business judgment" may be conceded. They sell boilers on the merits of their reputation, give good material and liberal proportions, and generally good satisfaction; and it is good "business judgment" to keep on selling boilers in just that way, with as little bother as possible concerning tests. But these same boiler makers are apt to be anything but good judges of what can be done with their boilers with different kinds of fuel and under different conditions, or of how to burn different kinds of fuel under their boilers to obtain the best results. Examples of the prevailing ignorance among boiler makers of what they can do with their boilers must have frequently come under Mr. Bryan's observation. In the case now under discussion, one maker offered 25% more grate surface and 48% more heating surface than the other; one or other of the bidders must have underrated or overrated the capacity of his boiler. In a former competition for supplying boilers to the St. Louis water-works the successful bidder failed to make good his guarantee, showing ignorance on his part as to what he could do with his boiler. If Mr. Bryan is able to form a conclusion as to the relative value of a square foot of heating surface in two different boilers by studying the differences of construction, we hope he will before long give the public his method of forming such a conclusion in the shape of a paper read before one of the engineering societies. We have no doubt such a paper would lead to a lively discussion, and bring out a variety of different opinions on the subject.—Ed.)

THE APPLICATION OF PHOTOGRAPHY TO SURVEYING.

The first practical application of photography, on this continent, to the continuous survey of large areas, is due to the experiments and patient and intelligent work of Mr. E. Deville, Surveyor General of Canada. This method of obtaining topographical data was first suggested in 1850, by Col. Laussedat, of the French army; and later, German and Italian engineers continued his investigations and elaborated upon his methods. But the system seems to have been entirely abandoned in France, and in Germany it is mainly used for making plans of buildings; but the Italians have instituted the Ordnance Photographic Survey, and under the able engineer M. Porro, they have vastly developed the system and have done some remarkable work. In America, Lieut. Henry A. Reid, U. S. A., has published an excellent work upon "Photography Applied to Surveying," in which he gives the detailed history of the process and describes the instruments and methods employed. But the Canadians, alone on this continent, have made a practical application of the system upon any extensive scale.

Until a few years ago the land surveys of the Dominion Government were chiefly confined to the prairies of Manitoba and the Northwest Territories, where the operations were simple and topographical features were scarce. But when these surveys reached the Rocky Mountains the conditions changed; topography became well marked, and the old system of section lines became useless, if not impossible in application. Government administrations demanded a fairly accurate map and some means had to be devised for making this map rapidly and at a moderate cost. As the ordinary methods of topographical surveying were too slow and expensive, and as rapid surveys, based upon triangulation and sketches had been tried and proved ineffectual, photography was resorted to.

The principle of the method employed and a summary of work actually performed in the Dominion is given by Mr. John S. Dennis, of Ottawa, Canada, in a paper read before the Denver meeting of the American Society of Irrigation Engineers. From this paper we make the following abstract:

"The method used is based upon the fact that a photograph taken with a suitable lens is a true perspective, in which the focal length is the distance line. By drawing the horizon and principal lines all measurements usually taken on the ground can be obtained from the photograph. But there is this difference, that while the ordinary surveying instruments and methods restrict the surveyor to a few constructions, photography affords a great variety of processes by applying the inverse laws of perspective. Mr. Dennis does not enter into the detail of the methods used, and refers those interested to the work of Lieut. Reid; but he gives the results of the surveys thus made. Regular photographic surveys were commenced in 1888, in the main range of the Rocky Mountains, near the Canadian Pacific Ry., and 250 square miles were covered in that year. From that time from 375 to 500 sq. miles were thus surveyed each year until the aggregate area covered, at the end of 1892, was 2,025 sq. miles.

These surveys were all made by a party consisting of the topographer, one assistant, a packer and a laborer. It has now been established that 500 sq. miles is about the limit of area which a party, travelling rapidly, can cover in one season; though this area is, of course, affected by the general character of the ground; being largest in an open district with wide undulations. The topographer does not need more than a few minutes at each station, to observe angles and expose his plates. As showing the general advantages and the rapidity of the work, the season of 1892 is taken as follows: The start was made on June 29, the snow being too deep for work before that date, and the survey was stopped on Oct. 17, when the snow again became too deep for travelling. Of the 111 intervening days 48 were lost through smoke, rain and snow storms; in the 63 actual working days thus left, the equivalent of 500 sq. miles of territory was surveyed, an average of 8 sq. miles per working day.

The results of the survey are plotted on a scale of 1—20,000, and reduced for publication to 1—40,000. The published "Anthracite" sheet, with an area of 63 sq. miles, may be taken as an illustration of practice. This plot was made from 6 stations inside the sheet and 11 stations outside, and 1,075 points were fixed by intersections, or by constructions equivalent in accuracy, taken from 35 photographic views. This corresponds to 17 points per sq. mile; though more points could be fixed without difficulty as the limit is the time which can be devoted to plotting. The office rule is that the topographer must plot his season's work before going into the field again; though more detailed maps of any particular locality can be made at any time from the same photographs. The expenses of the season of 1892 were:

Packer, $2.00 per day; laborer, $1.50 per day...	$429.00
Transportation	578.50
Living expenses	394.71
Miscellaneous	76.98
Total	$1,479.19

To this add $1,500 per annum for the salary of the topographer and $730 for that of his assistant, and the total is $3,709.19, as the cost of surveying 500 sq. miles in one year. This is equivalent to $7.42 per sq. mile, or 1.15 cts. per acre. This extremely low cost is due to the fact that the party is very small, and very little time is consumed in taking angles and photographs, and no time is required in taking measurements on the ground. The time spent in the field is chiefly devoted to travelling from one point to another, and the actual work of deducing results from the data thus collected is done in the office by two men.

Mr. Dennis believes that this method could be successfully and economically applied to surveys made in connection with irrigation enterprises. On the Canadian maps the contour intervals are 100 ft.; but a detailed plan of the area covered by any one sheet could be made to a larger scale from the same photographs, and contours shown at any intervals required. The strongest point in its favor, however, would be the rapidity with which the work could be done; though economy in first cost of the survey is also often a vital consideration. It should be stated that the application of the method requires experience and a combination of the faculties which make an accomplished topographer. He has nothing before his eyes to show the progress of the work, or the gaps that may exist in it; so that he must ever be on the watch, and depend upon his judgment and experience for the data actually transmitted to the home office for record. Another peculiarity of photographic surveying, which applies directly to irrigation engineering, is that the same photographs can be used for a small scale general map, or a large scale detailed map, and a return to the ground for additional data is unnecessary.

PHOTOGRAPH USED IN THE CANADIAN TOPOGRAPHIC SURVEY, SHOWING METHOD OF PLOTTING.

The photograph here reproduced is one of several used by Mr. Dennis in his paper, and illustrates some of the intersections made for defining the boundaries of Bow Lake, and for obtaining other topographical data at that place.

THE EXCLUSION OF TRUCKS from Fifth Ave., New York city, between 25th and 59th Sts., has been reported upon by the Street Committee of the Board of Aldermen, and favored only in a minority report. The majority reported that few people came before the committee desiring the restriction, while many protested against it. The minority denied that there was any purpose of turning the street over to a privileged class; and argued that the restriction would simply convert this avenue into a pleasure thoroughfare for the whole community. When this street is paved with asphalt, as proposed, some restriction will become a necessity to preserve the street from the almost exclusive use of heavy vehicles which will seek it because of easier traction. Other parallel avenues exist which could be used by heavy teams, and it seems that all interests should be united in thus preserving the only handsome approach to Central Park. Both reports have been laid over and ordered printed.

A MUNICIPAL ELECTRIC LIGHTING PLANT FOR Philadelphia is to be reported on by Mr. Jos. J. de Kinder, M. Am. Soc. M. E., Mr. M. Richards Muckle, Jr., and a third person to be selected by these two. The city owns a large gas plant.

STEEL CANAL BOATS.*

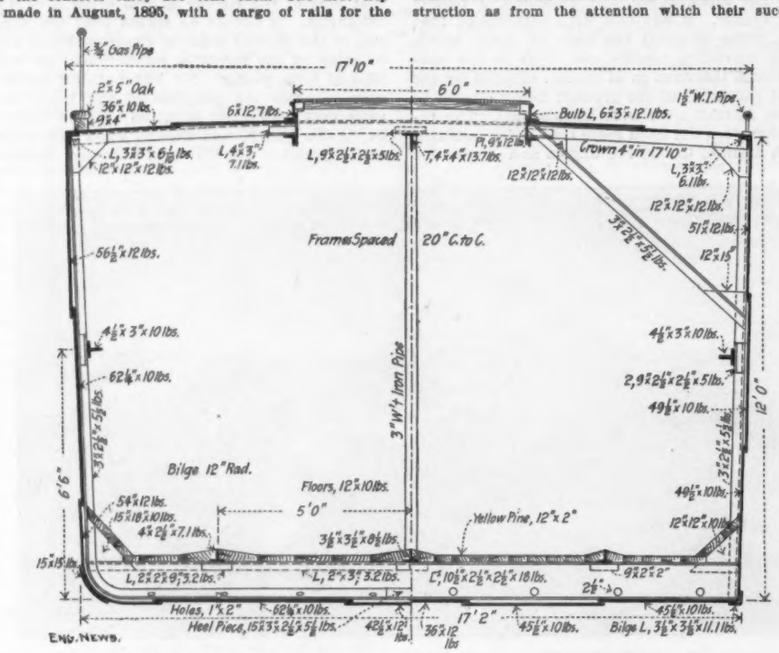
By Lewis Nixon, M. Soc. N. A. & M. E.

The appearance of the first fleet of steel canal boats on the Erie Canal was due to an investigation by the Cleveland Chamber of Commerce, which revealed the fact that the poor showing by the manufacturers of that city in the East was due to their inability to compete in Eastern markets on account of the heavy freight charges. It was found that the reason Buffalo had better freight rates was due to the competition of the Erie Canal from that city to New York. Mr. Charles E. Wheeler, the Secretary of the Chamber of Commerce, suggested the building of a fleet of steel boats to take freight through without transfer, from Cleveland to New York. Great prejudice was found along the canal against such a project, as it was claimed that the rocky bottom would seriously injure the steel vessels, and that no canal boat could weather the storms of Lake Erie. The first fleet, constructed in 1895, set at rest all doubts as to the fitness of steel boats for the service. This fleet consisted of a steamer and five consorts, all being 98 ft. long, 17 ft. 10 ins. wide, and 10 ft. deep. The steamer is driven by a fore and aft compound engine of 120 HP., and carries 125 tons of freight, while the consorts carry 230 tons each. The first trip was made in August, 1895, with a cargo of rails for the bars. The main hatch is 30 ft. long. This hatch is framed with a 6-in. bulb angle, forming a girder in connection with a 9-in. plate, and this girder is braced to the frames by 3½ × 2½-in. × 5½-lb. angle struts. Wooden hatch covers are fitted and a tarpaulin cover is secured over this by means of iron clamps, wedges and battens worked on the coaming.

The steamers are built with rounded bilges, but with about the same general construction as the barges.

The vessels are now run in fleets of one steamer and three consorts, carrying in all about 1,000 tons. Four fleets are to be kept constantly en route, with three consorts in New York loading for the return trip, thus keeping the steamers always on the go. A reduction of expense of about 40% is effected by the use of steam as compared with horse towing. The greatly increased fleet ordered after the first season's experience is an evidence of the commercial success of the venture. It is safe to say that this system of water transportation will reduce freight rates at least 25% over rail rates. A fleet makes about five miles an hour in Lake Erie, and from 3½ to 4 miles on the canal. The trip is made from Cleveland to New York in about ten days.

The importance of this growing fleet of steel canal boats arises not so much from the use of metal in their construction as from the attention which their success as



Half Section of Steamer. Half Section of Barge.

MIDSHIP SECTION OF STEEL CANAL BOAT, 100 FT. LONG.

New York street railways. A rock was struck shortly after leaving Buffalo, by which the vessels were lifted from 6 ins. to a foot out of water; but it was found, after careful inspection in dock, that no injury whatever was done the vessels, the greatest dent being about ¼-in. deep. On the first return trip a cargo of sugar was carried, consigned to houses in Cleveland and other cities, one railway leaving Cleveland being given a solid train of 36 cars of sugar. During this trip a very severe storm was encountered on Lake Erie, and, although the vessels were tossed about like corks and were often lost sight of from the steamer in the hollow of the waves, less than $100 worth of damage resulted to the cargo of $75,000 worth of sugar; and this was caused by improper loading.

In January, 1896, a further addition to this steel fleet was contracted for, consisting of three steamers and ten consorts. They were the same breadth and length as the first ones, but were made 2 ft. deeper with a view to utilizing the increased depth of 2 ft. of water in the canal. The steamers were given engines with cylinders 12 and 24 ins., by 16 ins. stroke, and Roberts tubular boilers. These engines develop about 275 HP. The consorts were built with square bilges, as shown on the midship sections. Open-hearth steel was used in the construction, of a tensile strength of 60,000 lbs., and an elongation in 8 ins. of 20%.

The consorts have frames 3 ins. by 2½ ins., of 5½ lbs. per ft., spaced 20 ins. apart. Forward, the frames, floors, and beams are canted, and alternate frames for 18 ft. on each side of the stern are built as web frames. A heavy breast hook is worked across the stem. The floors are made of channels 10½ ins. deep, weighing 18 lbs. per ft. Keelsons and longitudinals are formed by heavy "T"

*Condensed from a paper read before the Fourth General Meeting of the Society of Naval Architects and Marine Engineers.

freight carriers has directed towards the possibilities of the Erie Canal, and the results in the way of water transportation throughout the United States which are sure to follow.

While the debt which the interior of our country owes to the railways is beyond calculation, the cost of carrying products by rail over such distances eliminates all chances of profit at the farm. The expensive equipment and great first cost of railways means that the freight charges must be regulated by the necessity for paying the interest on the bonds issued for such constructions. Expansion of capitalization, and, worst of all, excessive competition, followed by consequent combination, bring about a rate destructive of profit to the producer. Piled upon this are the transfer tribute demanded at Buffalo, and the excessive lighterage charges in New York. Of the $20 paid for bringing a car-load from Buffalo to New York, as much as $18 of it has been paid for lighterage by the railroad. Canal traffic does away with lighterage; the freight arrives already lightered. The railroads discriminate against package freight, so that the millers of the Northwest pay about three times as much per mile for transporting flour as is charged for sending wheat to the mills of England, Holland and France, where it is ground to compete on the spot with American-made flour, with the result that our millers must fail in their effort to make flour for export profitable.

An all-water route with no fixed charges, and using the cheapest form of equipment against five lines whose aggregate interest-bearing cost is not less than half a million of dollars a mile, possesses advantages not necessary to explain.

The movement of food products from Buffalo to New York by rail, and the subsequent shipment to New England and Europe, is one that if followed on the same lines much longer will prove disastrous to New York city, and reduce this great city to a second-class port. New York, unlike Philadelphia, Boston, Baltimore, Norfolk and Newport News, cannot hold out the inducements of free storage, immediate access to ship's side, and minimum port charges. The present conditions of freight handling are the worst that could be devised, even if plotted by an enemy. Nine-tenths of the freight is received on the New Jersey shore, where there are no accommodations for storage or shipment; for, as a terminal point, it is so overtaxed that vexatious delays, blockades of rolling-stock, and congestion of traffic, that flour cars that would form a train thirty miles long remained outside Jersey City last winter for months, awaiting a chance to unload. Brooklyn, where the greater part of this vast bulk of freight must be stored, because storage cannot be afforded in New York, cannot be used as a shipping point by railroads; so that the final shipment must be made from New York. The three great elements of a perfect port, viz:—provisions for receipt, storage, and shipment, are, for the railroads, provided respectively on the Jersey shore, in Brooklyn, and in New York, all separated by water. In each case the transfer must be made by lighters, with consequent inconvenience, delay and cost; and when sent to New England, we have the cars carried on floats eleven miles around the Battery and up the Harlem. In times of great cold, fogs, and winds, such service is brought to a standstill, and even at its best it is costly, slow and dangerous.

What is needed at present is a pier on North River for export; for storage, for accumulation; for New England, space must be given on the Harlem River; and for local distribution, wharves are needed on the East River, near the Battery. The export trade can be taken care of in the most excellent basin extending from 52d St. to 54th St.

During the open season of the canal, there will be a direct connection with New England by means of the New Haven system, from canal boats landing at Fishkill Landing, so effecting an enormous saving over the present cost of delivering food products to that section. As the economic possibilities of New York as a shipping port are developed, there are sure to be great warehouses built along the shores of Staten Island, fed by canals in summer and railroads during the winter.

For storing the great quantities of flour for New England's winter consumption, there is a canal basin just below Spuyten Duyvil, near the entrance to the new Harlem canal, where food products may be stored, and shipped via the Sound or by rail from the freight terminal of the New Haven R. R. at Mott Haven, close to the basin.

The local traffic of New York and Brooklyn is at present cared for at piers 2, 3 and 4, in the East River near the Battery. It is to be hoped that the charter for the Greater New York will be drawn to provide, not only for present needs, but for a proper development of the facilities that will, if properly utilized, check the decline of commerce, cheapen the food supply of the people of New York, and make it the gateway through which must pass the food products of New England and Europe. Without some such aid, the New England factories, located on a non-productive soil, cannot hope to continue in competition with western manufacturing towns situated in the midst of food-producing regions.

Already events are shaping themselves in the direction of a more perfect use of water transportation. The people of New York by a direct vote have decided to expend $9,000,000 during the next two years in deepening the entire channel to a depth of 9 ft., and enlarging the locks, thus increasing the freight carrying capacity by at least 25%, with no increase in the cost of transportation. It is confidently expected that when this is done, freight can be carried at the rate of one mill per ton per mile. Railroads paralleling this canal cannot carry freight for an average cost of less than five times this sum,* for, even more striking than the contrast between the vast capital needed to compass a great freight movement by rail, where roadbed and equipment are most expensive, and the small amount needed by canal, where roadbed is free and equipment cheap, is the difference in cost of carriage between the two systems.

Taking a fleet on the deepened canal, of five consorts and one steamer, carrying 68,000 bushels of wheat, we find that to carry this wheat by rail will require two trains of 68 cars and two locomotives. When the freight arrives at the harbor of New York on the cars it must be lifted into a costly railroad elevator, then put into a lighter, towed alongside of a ship, and again elevated; or if it is to be stored it must be taken to Brooklyn, all the other transfers being required subsequently. The canal-boat freight can be carried direct to the vessel's side and elevated.

The use of barges of great proportionate freight-carrying capacity, drawn by powerful tugs or by vessels similar to the barges (but with freight capacity reduced enough to carry machinery), has been shown to be a commercial success, not only on the canal, but by large handlers of coal and oil at sea; and while such a change in the handling of freight by affording safe, sure, and regular de-

*Railways are now handling such bulk freights as are carried on canals at a cost of only two or three mills per ton per mile, where the volume of traffic is large and full train loads can be hauled long distances.—Ed. Eng. News.

...veries will strike a blow at our coasting schooner fleet, it cannot help but materially reduce the cost of transfer by water; while all forms of water carriage will assist in regulating freight rates on land.

The last report of the State Engineer of New York, Mr. Campbell W. Adams, gives a description of the Cleveland steel canal boats, in which we find the following information in addition to that given by Mr. Nixon:

The cost of this fleet will approximate $15,000 for the propeller and $6,000 for each consort. The best time made by the boats was 13 days from New York to Cleveland, they being loaded to 6 ft. draft. The best time from Cleveland to Buffalo was 30 hours in good weather, a loss of 4 hours of this time was due to a jam of boats at Tonawanda. * * * Their entire ability to weather any storm on the lakes has been proved to the entire satisfaction of the company.

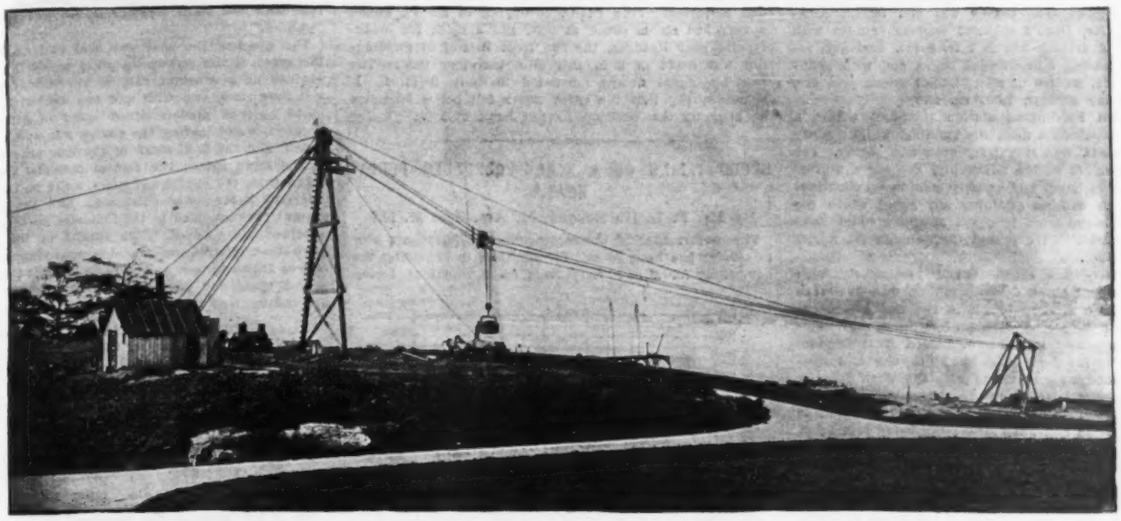


FIG. 1.—CABLEWAY FOR CARRYING EARTH AT WEST SEVENTY-NINTH ST., NEW YORK CITY.

NOVEL ARRANGEMENT OF A TRAVELING CABLEWAY

The accompanying cuts represent a cableway with a novel design of tower, which has been built by the Lidgerwood Mfg. Co., of New York city for the use of James Flanagan & Co., contractors, in unloading earth from scows at the foot of West 79th St., New York city. The earth had to be taken to a distance of about 500 ft. from the scows, up steep banks and over a railway, the general location being shown in Fig. 1. Teams were used at first, but were abandoned on account of the difficulty of hauling up the heavy grades. The cableway was finally adopted, and it is admirably adapted for the work, being located overhead and out of the way of the railway traffic, which is very considerable at this point.

The overhanging tower at the river terminus, which is shown in Fig. 2, enables the carrying bucket to be dropped directly into the scow and loaded, making the operation rapid and direct. The empty buckets are filled while the loaded one is in transit. The plant handles daily a scow load of about 400 cu. yds. The buckets used are of 1 cu. yd. capacity. The main cable is 1½ ins. diameter, for a load of 1½ tons. The hoisting engine is of the Lidgerwood design, with cylinders 9×10 ins., and double drums of large diameter. The engineman controls the entire operation of hoisting and delivering.

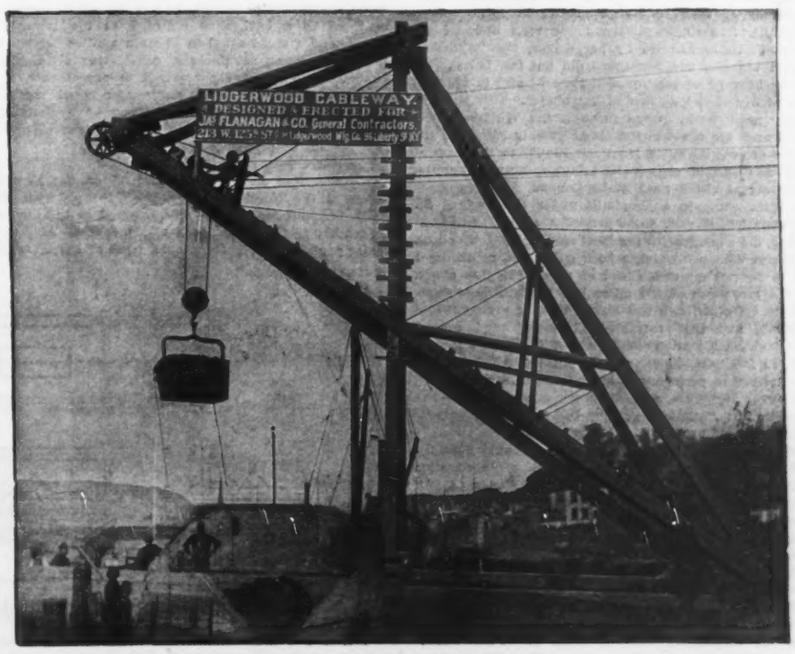


FIG. 2.—OVERHANGING TOWER OF CABLEWAY AT SEVENTY-NINTH ST., NEW YORK CITY.

THE LONGEST CONTINUOUS RAILWAY RUN IN THE WORLD.*

Ever since the middle of July the Great Western Ry. has daily made the longest run without stop ever yet regularly performed day by day by any railway in the world. The 10.25 a. m. train from Paddington station (London), which is the westbound Cornwall express, has run every week-day without a stop to Exeter, a distance of 194 miles. I do not assert that this run is the longest ever made, for I have not forgotten either the experimental run of 299¼ miles made by the London & Northwestern Ry. last year, or the occasional trips of the "American special" on the same line between London (Euston) and Liverpool (Riverside station) without a halt. But no such run as this of the Great Western Ry. has ever been made in ordinary daily practice, the nearest approach to it being that of the London & Northwestern from London to Crewe (158 miles), which is 36 miles shorter. In railway working, however, as in other mundane affairs, promise and performance are not always identical things, and it becomes interesting to see how the remarkable promise of the Great Western Ry. special time-table is fulfilled in actual working. The timing of this 10.25 a. m. Great Western down express is as follows:

Miles		
	Paddington	depart 10.25
194	Exeter	arrive 2.10

This represents an average speed from start to stop of 51.7 miles an hour. That, although a good rate of speed, may at first sight seem mild after the averages of some of the Northern lines; but several qualifying circumstances have to be taken into account, and when allowance is made for these drawbacks, it will be seen that the work demanded from Mr. Dean's fine engines is of a very high class.** That the down road for the first 117 miles or so is one of the easiest in the world may be readily admitted. But the passing of Bristol without entering the station has its serious disadvantage in point of road. It involves a diversion by way of the loop line, several chains longer, with a series of sharp curves which cannot properly be passed over (and, as a matter of fact, are not passed over) at a higher velocity than ten miles an hour; and the mile of the loop line by which the Bristol station is avoided occupies over three minutes in passage. Thus, nothing is gained by the train through passing by Bristol, except the escape from imminent risk of detentions through "blockings" by signal. The Bristol & Exeter Division is, as a rule, constructed on easy gradients, but the Wellington grade would be deemed severe even on the mountainous lines of the North, culminating—after several miles of 1 in 163, 1 in 132, and 1 in 103, started at slow speed, slackening through Taunton—in a mile and a quarter at 1 in 91, a mile at 1 in 81, and a mile at 1 in 126. So that to haul a train of heavy corridor coaches is by no means an easy task.

*Extract from an article by Mr. Charles Rous-Marten in the "Engineer," London, England.

**Mr. Wm. Dean is Locomotive Superintendent of the Great Western Ry., and a large number of the engines have been designed by him and built at the company's shops.—Ed. Eng. News.

Every facility of investigation having been most readily and courteously afforded to me by the Great Western Ry. authorities, I traveled by the 10.25 a. m. train from Paddington to Exeter on Sept. 7. The weather was favorable throughout, without side wind, and the rails were in good order. The train consisted of six bogie clerestoried corridor coaches (i. e., monitor roof cars, mounted on trucks—Ed.) weighing in all approximately 140 tons behind the tender. The engine was No. 3001, "Amazon," one of Mr. Dean's splendid express engines with a single pair of driving wheels 7 ft. 8 ins. diameter, rebuilt with a leading four-wheeled bogie, and with cylinders 19 × 24 ins. in lieu of 20 × 24 ins.; steam pressure, 160 lbs.; heating surface, 1,561 sq. ft.

Starting from Paddington station (London) within a few seconds of schedule time, the running, while slightly faster than usual, was singularly even and steady. The driver managed his engine admirably, keeping a minute or two always in hand, and quickly making up each loss by signal check without attaining any speed which the most timid passenger or ignorant alarmist could have deemed "excessive." We passed Chippenham (94 miles) in 98 min. 50 sec.

This manifestly was excellent and particularly even running. A signal check at Bathampton, due to a slow train having been allowed to get in the way of the express, caused a loss of a couple of minutes, but milepost 105¼ was passed in 112 min. 53 sec. from London, without allowing for the 2 mins. lost by the check. I mention this distance, as comparison with the work done on two runs of identical length on other lines may be of interest. Bath station was passed at the reduced speed of barely ten miles an hour, the slackening being protracted for a considerable distance before full speed was resumed. The actual time from London to Bath was 115 min. 47 sec., equivalent to 113¾ mins. net. At Salford another vexatious signal check was encountered, and for the third time our speed was lowered to ten miles an hour, or less, involving a further loss of at least 2 mins. We were abreast of Bristol station in 2 h. 10 min. from London, equal to a run of 126 mins. net, allowing for the time lost by signal checks, but not allowing anything for the "service" slack through Bath. It will show how very cautiously the curves of the diversion loop were negotiated when I mention that the distance of 1,980 ft. from Pylle Hill Junction to Bedminster station occupied 1¾ mins.

With the resumption of our main line running, speed was rapidly regained, and rose to a high point down the short descent of 1 in 200 approaching Yatton; maintaining a rapid pace, the 161¼ mile-post was passed in exactly three hours from Paddington. Here, however, a permanent way relaying slack brought down our average, but Taunton was passed in 3 h. 2 min. 41 sec. from the start. Then began the ascent of the Wellington bank—that terror of the broad-gage engine in former days. Mr. Dean's fine single-wheeler made very little of the incline. Skilfully handled by her driver, the "Amazon" mounted bravely, and her speed did not fall below 34.6 miles an hour up to the top of the ascent of 1 in 81, with a load of over 140 tons behind her tender. This was undeniably good work. Once through the Whiteball tunnel and over the summit, the speed quickly rose, and the distance of just 20 miles from the tunnel to the stop at Exeter was run in exactly 19 minutes, notwithstanding another signal check near Stoke Canon.

The train came to a standstill under the roof of St. David's Station, Exeter, at 2.2 precisely, according to London time, 2.4 according to the local station time, which on comparison with my watches both going and returning I found to be two minutes ahead of the Paddington clock. Thus the great run of 194 miles had been made without a stop (in spite of three bad signal checks, a permanent-way slack, and the protracted slowings round Bristol and through Bath station) in 3 h. 36 min. 43 sec., that is to say, in 216 min. 43 sec. (53.76 miles per hour). The engine arrived in perfect trim after being in constant motion for over 3½ hours, with all bearings cool, and everything quite fit for another long run had this been required. Water was picked up twice while running.

As for the traveling throughout, nothing could possibly have been steadier, smoother, or easier than the running of the splendid bogie coaches which formed the train. At the highest velocities or round the sharpest curves their steadiness was all that could have been desired by the most exacting traveller. In all respects it fully equalled the running of the newest twelve-wheelers employed in the Scottish traffic, and assuredly no higher praise than this could be awarded.

My return journey was made by the second part of the up Cornish express. It had been detained at wayside stations for luggage, notably 20 mins. at Truro, where room had to be found for no fewer than 27 bicycles, when the vans were already crammed. Consequently we started from Exeter 34 mins. late. The load consisted of nine corridor bogie cars and a six-wheel car, representing a total weight behind tender of about 515,200 lbs. Two of Mr. Dean's large 7 ft. 8 in. singles, Nos. 3047 ("Lorna Doone") and 3050 ("Royal Sovereign") took the train to Bristol—75½ miles—without a stop in 85 mins., or 3 mins. under time; the 44¾ miles from Taunton, after passing that station at reduced speed, being done in 48 mins. to the stop at Bristol. A very even rate of speed was generally maintained, and the traveling was as smooth and easy as on the down journey. At Bristol the six-wheel car and two bogie cars were taken off, bringing down the load to approximately 369,600 lbs., taken by another 7 ft. 8 in. single-wheeler, No. 3007 ("Dragon"). In spite of two extra stops (at Swindon and Westbourne Park), occupying in all 4¼ mins., a very bad signal check at Box, and a slack for bridge repairs near Reading, the run from Bristol to Paddington was made in 2 h. 13¾ min. traveling time. The loss by signal delays amounted to fully 9 mins. It is noteworthy that the speed never fell below 56 miles an hour up the Wootton Bassett bank of 1%.

SPEED TRIALS OF A SCREW-PROPELLED FERRY-BOAT.*

By Mr. F. L. Du Bosque, M. Am. Soc. M. E.†

The performance of the screw-propelled ferryboats now in service has been so satisfactory that, in providing the equipment for a new ferry from its terminal at Jersey City to 23d St., New York, the Pennsylvania R. R. Co. decided, from the experience they had gained with the screw boats it now operates, to adopt the same method of propulsion for the new ones. The service will require more speedy boats—in fact, as fast as can be consistently operated in a harbor as crowded as the lower North River—and a speed equal to 15 statute miles per hour was decided upon as satisfactory, considering all conditions. To determine the power required to propel such a type of ferryboat at this speed, progressive speed trials were made with the screw-propelled ferryboat "Cincinnati"; incidentally, data were taken to determine the efficiency of this system of propulsion.

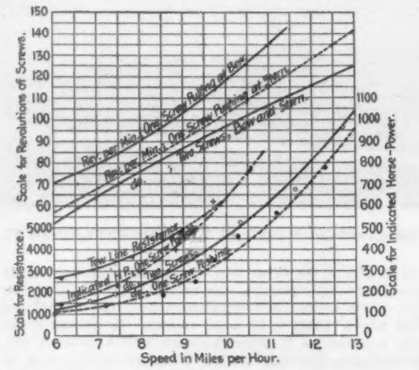

Scale for Revolutions of Screws.
Scale for Resistance.
Scale for Indicated Horse-Power.
Speed in Miles per Hour.
Rev. per Min., One Screw Pushing at Stern.
Rev. per Min., One Screw Pushing at Stern.
Rev. per Min., Two Screws, Bow and Stern.
Tow-Line Resistance.
Indicated H.P., One Screw Pushing.
Indicated H.P., Two Screws.
Indicated H.P., One Screw Pulling.

Fig. 1.—Diagram Showing Tow-Line Resistance, Indicated Horse-Power, and Revolutions of Screws at Different Speeds of the Ferryboat "Cincinnati," Pennsylvania R.R.

The trials were made as follows:

A distance of 5,600 ft. was laid off on the New York shore of the North River, extending from 94th St. to 115th St., and range poles were erected at the terminals, perpendicular to the direction of the course. At this particular part of the river there is a depth of seven fathoms, and the course is so located that projecting points of land beyond the course act as range marks, so that a boat can be steered back and forth, at uniformly the same distance from the shore, through the same strength of current, and in a straight line.

Runs were made on this course, with and against the tide, at speeds varying from 6 to 13 statute miles per hour; one series with the two screws in operation, one at the bow and one at the stern; one series with the bow screw removed and stern screw "pushing," and one series with the stern screw removed and the bow screw "pulling."

The speed of the boat was held uniform by governing the speed of the screws—in other words, by running the engines at a constant rate of revolutions per minute—and four runs, two with and two against the tide, were made at each predetermined speed of screw; the time of entering and leaving the course was noted with a stop-watch, and the final mean of the four observations taken as the mean speed; two sets of indicator diagrams were taken from the engine cylinders while on the course, the indicated horse-power calculated, and the mean of the several runs accepted as the indicated horse-power for the observed mean speed. The results of the observations have been plotted on the accompanying diagram, and curves drawn to pass as nearly as possible through the observed speed and power. This curve shows facts which are summarized in Table I.

TABLE I.—Efficiency of Various Arrangements of Screw Propulsion at Various Speeds.

Speed. Statute miles per hour.	1 Screw Pushing.			2 Screws.			1 Screw Pulling.		
	I. HP.	Revs. per min.	Slip. %	I. HP.	Revs. per min.	Slip. %	I. HP.	Revs. per min.	Slip. %
9	250	91	19.5	332	87	20	443	103	35.5
10	364	103	24.5	464	97	20.5	638	118	36
11	520	115	27.5	624	107	19	880	135	35
12	720	128	28	816	116	18.5			

The I. HP. given is that developed by the main engines only, and does not include the air, circulating or feed pumps.

To determine the efficiency of the system, the screws were removed and the boat towed over the measured course, twice with and twice against the tide at three different speeds, and the tow-line strain measured by a dynamometer.

The resistance observed is plotted on the accompanying diagram, Plate I, and the curve produced shows results which are given in Table II.

TABLE II.—Resistance and Work of Screws at Various Speeds.

Speed in miles per hour.	Resistance, both screws removed. Pounds.	Indicated Thrust.		
		One screw pushing. Pounds.	Two screws. Pounds.	One screw pulling. Pounds.
8	3,880	6,700	9,050	9,380
9	4,950	8,200	11,350	12,100
10	6,400	10,250	14,120	15,440

It will be noticed that the proportion of the power put into the engine which is utilized in overcoming the actual resistance of the boat at 9 miles per hour is 43%, when two screws are in use; 60% when one screw is pushing, and 40% when one screw is pulling.

The usual speed of this boat in ferry service is 11 miles per hour, and at this speed it requires 20% more power to propel the boat with two screws than with one screw pushing, and 69% more power to propel the boat with the screw at the bow than at the stern. If the same power could be put into one screw at the stern as is used by the two screws, the speed would be increased from 11 miles to 11.53 miles per hour. It is clear, therefore, that the bow screw is inefficient. When under way, it thrusts a column of water against the bow of the boat at a velocity equal to the slip ratio of the screw, and considerable power is absorbed through friction of the blade surface; but a ferryboat's bow becomes its stern at each succeeding trip, and it is therefore impossible to dispense with the forward screw.

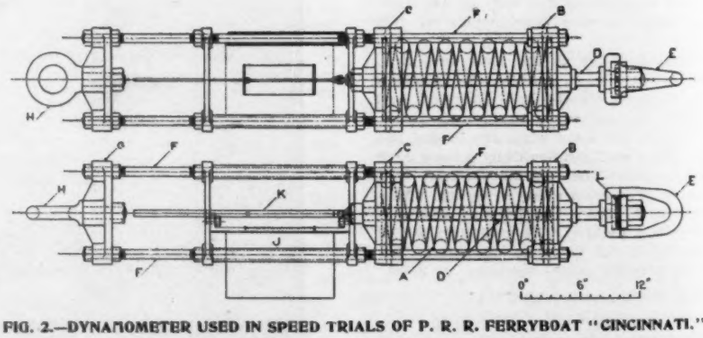


FIG. 2.—DYNAMOMETER USED IN SPEED TRIALS OF P. R. R. FERRYBOAT "CINCINNATI."

*A paper read at the fourth general meeting of the Society of Naval Architects and Marine Engineers, New York, Nov. 12, 1896. An illustrated description of the ferryboat "Cincinnati," on which the trials described in this paper were made, was published in Engineering News of Nov. 7, 1891.

†Engineer of Floating Equipment, Pennsylvania R. R. Co., Jersey City, N. J.

The screw at the bow, however, is useful, for one of the most desirable features in a ferryboat is the ability to start and stop promptly. Of the seven minutes required to go from landing to landing, two minutes are consumed in getting under way and stopping. Superiority in this respect is one of the reasons why a screw boat is preferable to a side wheeler. A half minute is more easily gained in maneuvering by using screws than by increasing the speed of the boat when under way, and it is in stopping and backing that the forward screw shows its usefulness; it is able to thrust a column of water directly ahead that will not impinge against the boat. Several means have been suggested to overcome the loss due to the use of this forward screw when underway, the most fascinating of which seems to be to so design the screw that it will have very little backing power. If this could be done, the propelling effect of the forward screw would be small, and the power required to turn it would probably be only that due to the surface friction of the blades.

The screw-propelled ferryboat is a type now so well known that it seems unnecessary to describe it, and to the few interested in the subject sufficient information is given in the accompanying plates to analyze the distribution of the power required. The service required from a ferryboat is so peculiar that the form of the hull, and the means of propelling it, are necessarily different from the usual type of boat. The propeller shaft is continuous from end to end, and to sufficiently submerge the screws the engines must be low; this requires a greater draft than a side-wheel propelled boat. On account of the height and weight of the superstructure for the accommodation of passengers and teams, the breadth on the water-line must be great, not to prevent capsizing, but because the greater number of the passengers carried are unused to the sea and become alarmed at a slight angle of heel, which is exaggerated by the great breadth of the decks. The metacentric height of the "Cincinnati" is 9 ft., and is not thought to be too great. The breadth of the water-lines is carried well to the ends to give longitudinal stability, so that the ends will not be depressed by the weight which gathers there in loading and unloading the boat. These conditions, it will be seen, impose extreme proportions; the amidship section is "V" shaped and the volume of the hull is but 46% of a circumscribed parallelepiped; though admitting of very fine water-lines and section-lines the ratio of wetted surface to displacement is much larger than usual.

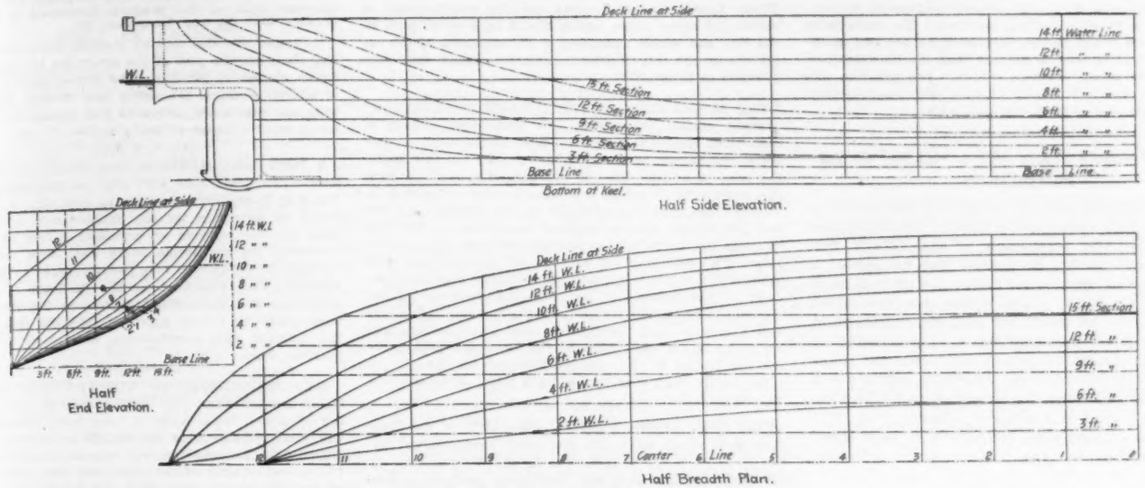


FIG. 3.—LINES OF HULL OF P. R. R. FERRYBOAT "CINCINNATI."

DIMENSIONS.

Length on keel	180 ft. 0 ins.	Displacement	953 tons
" " water line	200 " 0 "	Coefficient of fineness block	46.66
" over all	206 " 0 "	" " water lines	75.50
Breadth at water line	39 " 3½ "	" " immersed midship section	61.54
" " deck	46 " 0 "	Area immersed midship section	344.14 sq. ft.
" " over all	65 " 0 "	Wetted surface	7469.40 "
Depth deck amidship at side to base line	18 " 6 "		
" water line to base line	10 " 1¼ "		
" of keel	5 "		
Draft, extreme	11 " 2¼ "		

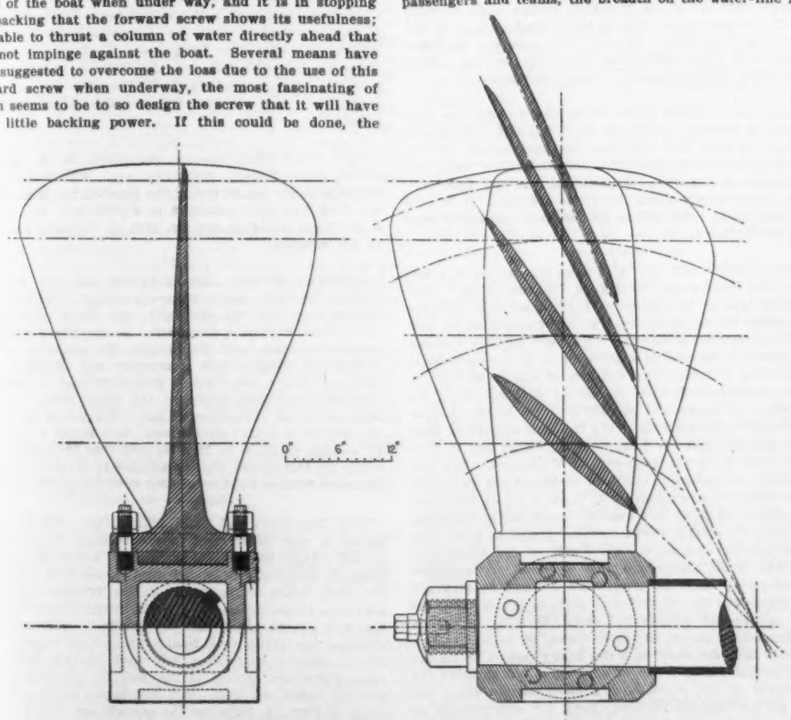


FIG. 4.—PROPELLER OF P. R. R. FERRYBOAT "CINCINNATI."

(Material, Cast-Steel; Diameter, 8 ft. 6 ins., Pitch, 11.3883 ft.; Disk Area, 113.49 sq. ft.; Developed Area, 32.26 sq. ft.; Projected Area, 26.57 sq. ft.)

The forms of hull and propeller of the ferryboat experimented upon are shown in Figs. 3 and 4, respectively.

The screw-propelled boat will eventually supplant the side-wheeled boat for ferry service, where certainty in the operation of the ferry is necessary, and where the comfort of the passengers is considered. As before stated, the boats are more quickly maneuvered at the landings, and in the winter they proceed through the ice without interruption, when the side-wheeled boats are very much delayed. A comparison of the power required to propel either type of boat shows results in favor of the side wheel. The "Cincinnati" and "Chicago" are operated on the same ferry, and their speeds are about the same.

	Propellers.	I. HP.	Displacement.	Speed.
"Cincinnati"	Screws.	624	952 tons.	11 miles.
"Chicago"	Side wheels.	630	775 "	11 "

If the power required to drive these boats varies as $\sqrt[3]{\text{displacement}^2}$, and the boats were brought to the same displacement, this would be the result:

	I. HP.	Displacement.	Speed.
"Cincinnati"	624	952 tons.	11 miles.
"Chicago"	608	952 "	11

The I. HP. of the "Chicago" includes the jet condenser.

It can, no doubt, be safely said, therefore, that the side wheel is a more economical propeller for a ferryboat than the two-screw arrangement, but it must not be forgotten that the advantages gained by the use of the screw are more valuable for the successful operation of a ferry than the amount saved in power.

Dynamometer.

So much depends upon the accuracy of the dynamometer in making resistance trials, and such good results were had from the one used in these trials, that a plan of it is shown on Fig. 2. A steel spring, A, is fitted between two caps, B and C, and a rod D, rigidly connected with the cap C, passes through the spring and the cap B, and is fastened to the tow line by the eye E.

The cap B is rigidly connected with the four rods at F, F, which passes freely through the cap C, and are rigidly connected with the casting G. This casting is fastened to the boat by means of the eye H. At J is a drum revolved by clock mechanism, and K is a guided rod, carrying a pencil, and connected with the main rod D.

The device was mounted on the boat in such a way that it was entirely clear of the deck, and was free to swing in any direction, and to follow the "lead" of the tow line, but it was not permitted to rotate; therefore, to overcome any twisting strains that would cause friction in the device, a roller bearing was fitted at L, so that the eye E could revolve freely and allow for the twisting of the tow line.

When the spring is compressed by a strain applied by the tow line through the eye E, the amount of the compression is recorded, by a pencil carried in the bar K, on

a sheet of paper carried on the drum J; and as this drum revolves, the amount of the compression at any period of the run is recorded.

To determine the strain corresponding to various compressions, the complete device was calibrated by suspending weights from it and noting the amount of the compression. To determine the amount of friction, if any, the spring was taken from the device and tested between clamps in a reliable testing machine. No appreciable difference was found in the calibration by the two methods, so that is is safe to assume that the dynamometer measured the actual tow-line strains. The tow line was 360 ft. long, and it is hardly possible that the propellers of the towing boat affected the boat towed.

A WATER-WORKS PLANT FOR A VILLAGE OF 300 INHABITANTS.

A novel scheme for raising money for a water-works has been successfully carried out at Deansboro, N. Y. The population of the village was only 300, and no fire protection was available. A committee was appointed to appraise all buildings and their contents, after which fire protection was offered on all dwellings and out buildings in return for stock subscription to the amount of 2% of their appraised value; the rates for other buildings were as follows: Churches, schools and other public buildings, 2½%; stores and all buildings not included in the above classification, 3%. The owners of nearly all the buildings took stock and the works are expected to be in operation by Dec. 1.

The supply is developed from water-bearing gravel, water being collected by tile drains and brought into a central basin. From this basin the water is conveyed to the village, the main passing around the reservoir, and only the surplus above consumption going into the reservoir. This plan was adopted in order to prevent the possibility of the stored water being drawn off by excessive domestic consumption and leaving the village without fire protection.

The reservoir is excavated in red clay, and riprapped on its inner slopes. Its dimensions are 44×95 ft. at the top and 22×72 ft. at the bottom, the slope being 1 to 1. The water line is 8½ to 9 ft. above the bottom.

About 1¾ miles of mains have been laid, 13 hydrants set, and some 40 domestic services have been put in, or are expected. The pressure on the mains is given as 60 lbs. The company has an authorized capital stock of $4,000, but the cost of construction is not stated. We are indebted to Mr. Geo. I. Honey, secretary of the water company, for the above information.

Fire protection, as stated above, is furnished free to all stockholders. The rates to stockholders for a domestic supply are as follows: Family use, $5 per year; lawn sprinkling, $3; barns, $2.50. The rates to outsiders have not been fixed.

A MOTOR CARRIAGE RACE from London to Brighton, 52 miles, took place on Nov. 14, about 50 carriages starting. An American carriage, built by the Duryea Motor Carriage Co., won the race, making the run in about four hours.

VOTING MACHINES were used in several districts in the State of New York during the recent election. In most cases they gave complete satisfaction, but in some places they were found defective. In one district in Rochester the machine failed to register the votes of about 200 men, and the city council by a vote of 13 to 6 decided that the machines were not satisfactory and refused to pay for them.

A MONOLITHIC CONCRETE BRIDGE has been built at Detroit, Mich., to carry the Michigan Central R. R. across the new Boulevard. The arch is 50 ft. span and 13 ft. 6 ins. high at the center, and carries eight railway tracks. the bridge is of concrete and iron construction, having curved iron beams imbedded in the arch concrete, and the structure is faced with Berea sandstone. The bridge was designed by Mr. W. H. Ashwell, engineer of the Park and Boulevard Commission, and the contractor was Mr. T. J. Kennedy. The cost was about $30,000.

AN UNDERGROUND RAILWAY on Atlantic Ave., Brooklyn, N. Y., has been proposed by Mr. F. E. Storm, civil engineer, of that city, and the plans have been submitted to the Atlantic Avenue Commission. The work is to be all constructed in open cut, but the part from South Ferry to Fort Greene Place would be roofed over. From Fort Greene Place to the city line an open depressed track is provided for, bridged at each cross street and fenced in along the openings. The construction is to be of ironwork and concrete filling. The cost would be $2,433,525, divided as follows: From South Ferry to Fort Greene Place, 7,400 ft., at $65.30 per ft., $483,220; from Fort Greene Place to the city line, 31,100 ft., at $53.41 per ft., $1,652,654; 20 depressed stations, at $11,676.40 each, $233,528; 54 bridges, at $1,187.28 each, $64,113.12. These figures do not provide for the readjustment of water and sewer pipes, which would have to be done by the city, and which, according to the estimates of the engineers of the City Works Department, would cost from $500,000 to $1,000,000.

THE MILWAUKEE WATER INTAKE TUNNEL SUIT brought against the city by the contractors, Shailer & Schniglau, has been decided in favor of the city. A contract was signed in the summer of 1890 for this work, the price to be $250,000. In October, 1893, the city took the work into its hands and subsequently completed it. The city had paid about $80,000 on the contract and the suit just closed was for damages amounting to $170,000 to make up the difference between this and the contract price. Full details of the suit are not at hand, but such information as we have received indicates that the chief claim of the contractors was that the character of the material to be encountered was misrepresented. The city filed a counter claim for a large sum, partly as damages for delay in the completion of the work but principally for the excess of the expense incurred by the city to complete the work over the contract price. Neither claim was allowed.

THE EAST RIVER TUNNEL PROJECT, of the New York & Brooklyn R. R. Co., has been "turned down" by the Brooklyn Board of Aldermen by declining to take up the matter at this time and indefinitely postponing discussion. But Mr. Frederick B. Esler, representing the tunnel company, says that the company will now resort to its original plan providing for a Brooklyn terminus at the foot of Fulton St. This would be on private property over which the Brooklyn Board of Aldermen has no jurisdiction. The tunnel company has all the necessary authority from the New York Board of Aldermen, and the authority of New York extends to low-water mark on the Brooklyn side of the East River. The purpose of the tunnel is to connect the passenger railway systems of the two cities.

SWITCHING BY ELECTRICITY is now in use at the Brooklyn terminal of the Brooklyn Bridge cable railway. One of the new motor cars is being used instead of the steam switching engine, and all these cars will be tested in this way before being put into train service. They do the work quicker than the steam locomotives.

ELECTRIC POWER FROM NIAGARA FALLS was first utilized in Buffalo, N. Y., on Nov. 15, and the electric railways of that city are now operated partly by the current from the power plant at the Falls, this being, for the present at any rate, supplementary to the 4,000 HP. of the existing power plants of the railways. It is said that only about 1,000 HP. of the Niagara current is thus being utilized.

COMPRESSED AIR MOTORS form the subject of a late letter from Paris to the New York "Evening Post." The Mekarski system, introduced at Nantes, in 1879, includes the storage of air compressed to 25 atmospheres in reservoirs under the motor-car. This air passing through a regulator is reduced to a pressure of 5 atmospheres in the working cylinders, and the loss of energy in this reduction, estimated at 38%, is met by a reheating of the air before it enters the cylinders. The Mekarski system of motors is now used on the line from Nogent to Bry, on the Marne, from the Louvre to St. Cloud and to Versailles; and from St. Augustin to Vincennes. The objections to the system is the dead weight of the motor-car and its reservoirs, amounting to from 4 to 10 tons, and the necessity of going to a central station for re-charging. Otherwise, the system works well and grades of more than 6% are readily overcome. Mr. Popp, of the Compagnie Parisienne d'Air Comprime, now proposes to establish lines of piping carrying compressed air and so arranged as to charge the car reservoirs at short intervals along the route, and he has already laid down 2½ miles of such a line, furnishing air at 10 atmospheres, in Saint-Quentin. He would thus do away with the heavy reservoirs on the motor-car and claims a loss of only 1% in transmitting the compressed air 2½ miles, with a plant costing about the same as for electric traction; both for compressors as offsetting dynamos, and pipes as offsetting overhead wires and their supports. The extreme cost price of the Mekarski system, as originally used, is set down by this correspondent at 7 cts. per kilometer per motor car, or 11.3 cts. per mile, including the compression of the air, repairs, maintenance, interest, sinking fund and profit to factory. This is compared with 17.7 cts. per mile for horse-tramways in Paris. When the motor hauls another 50-passenger car, the supplementary expense is 3.2 cts. per mile. In Belgium, where labor and coal costs half as much as in Paris, the cost goes down to 6.4 cts. per mile for the motor-car.

THE REGULATION OF STREET TRAFFIC, by ordinance, has been attempted in New York city. The ordinance adopted applies to the Boulevard and provides that except when going or coming directly from or to their place of departure or destination on said Boulevard, and except when actually passing another vehicle or an obstacle, all trucks, express wagons, vans and business vehicles of all sorts shall keep in single line upon the extreme right of the Western Boulevard at all points between 59th St. and Manhattan St.

It further specifies that all bicycles and passenger vehicles shall use the part of the street not set apart for the above classes of vehicles. The enforcement of this law is already causing grumbling and trouble; but it is a wise and reasonable ordinance and should be applied on many other avenues of heavy traffic.

A PIER ROOF-GARDEN, upon the pier at the foot of East Third Street, New York city, has been ordered by the Board of Dock Commissioners, to meet the request of the Board of Aldermen for the establishment of such gardens for the purpose of providing places of healthful recreation for the people living near these piers. Plans for such a roof-garden have been prepared by Edward H. Kendall, Past President of the Institute of American Architects and consulting engineer to the Dock Board; these plans have been approved, and the preparation of the contract and specifications ordered at the earliest possible date.

THE PRODUCTION OF TIN PLATE in the United States for the fiscal year ending June 30 is reported by the Treasury Department to have been 307,228,621 lbs. The total imports were 385,070,372 lbs. and the exports 137,659,779 lbs., making net imports 247,410,593 lbs. The annual capacity of the mills completed and in process of construction on June 30 is 585,000,000 lbs., or more than the total of domestic production and net imports. Of the production, 98½% was made from sheets rolled in the United States. The report embraces the production of 53 firms making tin plates, and of 36 rolling mills producing black plates.

A HUGE GRANITE BLOCK has been quarried at Barre, Vt., for the Moriarty monument in New Orleans, but there is trouble in finding a railway that can take it, as its size is too great for the smallest bridges on some roads. The stone is 15 ft. square and 3 ft. thick.

THE HANKOW-PEKIN RAILWAY may be built with Chinese capital, says a Pekin dispatch. There is a hitch in the negotiations with the American syndicate which was lately reported as being ready to advance 30,000,000 taels for this purpose, and the Chinese government is now attempting to borrow 20,000,000 taels among native capitalists. This attempt will probably also result in failure.

THE PHILADELPHIA & READING R. R. and its leased lines, mining properties, etc., will probably be operated under the control of the Reading Co., whose capital stock has been increased to $40,000,000. Mr. Joseph S. Harris is president and Mr. Wm. R. Taylor is secretary of the company.

ACETYLENE GAS GENERATORS are now used to furnish light for magic lantern purposes. Calcium carbide is placed in the generator, and water admitted at the bottom through a stop-cock. As the water rises and comes in contact with the carbide, the acetylene is generated and escapes into a receiver and thence to the burners. When more gas is generated than is used the increasing pressure depresses the water level, and almost stops the generation of gas. The gas is burned in the lantern in four 1-ft. burners, each giving a perfectly white light of 125 c. p. It is claimed that the convenience of the apparatus will cause acetylene to entirely supplant the oxy-hydrogen light commonly used for magic lanterns.

THE VALIDITY OF THE BERLINER TELEPHONE patent is now being tried in the Supreme Court of the United States, argument having been begun on Nov. 9. Upon its decision will depend whether the Bell Telephone Co. shall retain its monopoly of the existing system of telephone transmission for 17 years from November, 1891, the date of the patent for the Berliner transmitter, or whether the system shall become free to the public. Berliner's original application was filed June 4, 1877, and came under the control of the Bell Co. in 1878, but it was not issued till 1891. Suit was begun by the government on Nov. 17, 1891, for the cancellation of the patent on the ground of the extraordinary delay, which it was claimed was in effect a fraud upon the public; and also on the grounds that a patent issued to Berliner in 1880 covered the same invention as that covered by the patent in suit; that the patent was not for the invention described in the application as filed. The first trial of the case before the U. S. Circuit Court for the District of Massachusetts, on Jan. 3, 1895, resulted in favor of the government; this decision was reversed on June 14, 1895, by the Court of Appeals for the First Circuit, and the government has now taken the case into the Supreme Court.